Transparency in the Practice of Monetary Policy

J. Alfred Broaddus, Jr.

This has been a very useful conference in my view, and I am honored by this opportunity to be a part of it. As some of you may know, I was the second choice for this slot, but that doesn't bother me at all because the first choice was Don Brash, the Governor of the Reserve Bank of New Zealand and a pathbreaker in bringing both transparency and accountability to central banking in practice. I won't be able to fill Don's shoes completely, but I have a strong interest in this topic, and I am very happy that Bill and Dan saw fit to give me the opportunity to share some thoughts with this distinguished group.

Actually, it is hard to imagine that anyone interested in improving the conduct of monetary policy would *not* be interested in this topic. There is a growing consensus among monetary economists at this point that the impact of monetary policy on expenditure is transmitted primarily through the effects of policy actions on expectations regarding the future path of short-term interest rates rather than the current level of the overnight rate.[1] Further, the more financial markets know about the reasons for a central bank's current policy actions and its longer-run policy intentions, the more likely it is that market reactions to policy actions will reinforce these actions and increase the effectiveness of stabilization policy. It follows that central banks should be highly transparent regarding both their long-term policy objectives and the shorter-term tactical actions they take with policy instruments.

Against this background, it seems to me that the Fed, along with other central banks, has made considerable progress in increasing transparency in

This article is the text of an address given by J. Alfred Broaddus, Jr., president of the Federal Reserve Bank of Richmond, before the 26th Annual Economic Policy Conference sponsored by the Federal Reserve Bank of St. Louis, Missouri, on October 12, 2001. The author thanks his colleague Marvin Goodfriend for his assistance in preparing these remarks. The views expressed here are the author's and not necessarily those of the Federal Reserve Bank of Richmond or the Federal Reserve System.

[1] See Woodford (2001, p. 17).

recent years. When I first joined the Fed back in 1970, to the extent that anyone thought explicitly about transparency issues at all, the idea seemed to be that limited transparency—or even no transparency—was best. Central banks in industrial democracies were thought to work most effectively behind the scenes, away from the glare of public scrutiny, at least in part because they could then quietly take appropriate actions that might be politically unpopular, or, more broadly, difficult to explain to a public not well versed in the intricacies of finance.[2] There was also a belief in some quarters that central banks could enhance the effects of certain policy actions—most notably foreign exchange market intervention operations—if they kept market participants uncertain about their intentions.

Attitudes toward transparency appeared to change in the 1980s, partly reflecting progress made by economists in understanding the monetary policy transmission mechanism, and probably partly because of public demand, particularly in the United States, for greater openness in government and public policy generally. (As you may recall, the most widely read popular book about the Fed and Fed policy in the 1980s was somewhat derisively titled *Secrets of the Temple*.) Further, in the early 1980s, Chairman Volcker publicly took responsibility for reducing inflation from its then high level, and subsequently took strong and temporarily painful actions to accomplish the reduction. Some public explanation of the need for these steps was required, and this need probably facilitated the transition to viewing transparency more favorably. In any case, given the normal resistance to change in bureaucratic organizations, I believe the Fed has made remarkable progress over the last decade or so in opening up its conduct of monetary policy to market and public scrutiny.

Since the Fed is now quite open regarding many important aspects of its policy strategy and operations, and in view of the strong performance of the U.S. economy in recent years, at least up until the last several quarters, one might reasonably ask whether still greater transparency is necessary or even desirable in U.S. monetary policy. I think it is, and I will try to make this case in the next few minutes. Let me comment briefly on four points: (1) the transparency of our long-term inflation objective, (2) what I'm going to refer to as the "intermediate-term transparency problem," (3) the transparency of our policy directive, including its "tilt," and (4) the role of testimony, speeches, and other public statements by Fed officials in providing transparency.

[2] See Goodfriend (1986).

1. TRANSPARENCY OF THE LONG-TERM INFLATION OBJECTIVE

Probably the most important thing the public wishes to know and needs to know with some precision about Fed monetary policy is our long-term objective for inflation. Longer-term inflation expectations are obviously critical to households and businesses in committing to long-term investments, home purchases, insurance contracts, and wage and benefit agreements. Conversely, the Fed needs the public to understand and trust its long-term commitment to low inflation to achieve maximum benefit from this long-term strategy.

How to convey this objective credibly to the markets and the public has been a major focus of our policy research at the Richmond Fed for a long time. For many years I've personally been convinced that controlling inflation should be the Fed's overriding objective, that this objective should be explicit, and that it should be supported by a congressional mandate. At one level, abstracting, for example, from political obstacles, this seems obvious. We know that the Fed has the ability to determine the long-run inflation rate with monetary policy, and theoretical analysis and all of our practical experience suggest we should use that power in the public interest to maintain low and stable inflation over time.

An explicit long-term inflation objective supported by a congressional mandate would be a substantially beneficial step, in my view, even if it were limited to a verbal statement along the lines of the language in the proposed Neal Amendment to the Federal Reserve Act.[3] Quantifying the objective in terms of an explicit numerical rate (say, 2 percent per annum using the core PCE inflation index) would make the objective even more transparent and probably more effective.

Committing to an explicit inflation objective would achieve at least three things. First, it would help anchor longer-term inflation expectations and therefore facilitate the longer-term transactions I noted earlier. Second, it would help prevent inflation scares in financial markets, which would allow the Fed to act more aggressively in response to downside risks in the economy with less concern that rising long-term interest rates might neutralize the effect of the action.

Third, and most importantly, an explicit inflation objective would discipline the Fed to explain and justify short-run actions designed to stabilize output and employment against our commitment to protect the purchasing power of the currency over the long run. An explicit objective would force such explanations and justifications to be more sharply focused than in the current regime without such an objective. Routine, clear explanations of short-term actions would build confidence in the Fed's commitment to price stability and

[3] See Black (1990) and Greenspan (1990).

over time help reinforce credibility for low inflation. If the explanations were made in testimony before Congress, supplemented perhaps by a written inflation report along the lines of the Bank of England model, Congress would be positioned to enforce an accountability for monetary policy that arguably is now weaker in the United States than in the United Kingdom and the European Monetary Union.

One final point here: The Fed's long-term commitment to price stability is now largely embodied in our current Chairman's demonstrated commitment to this objective, rather than being institutionally grounded in an explicit objective. It is therefore inherently tenuous since its continuance will depend on the preferences of future Chairmen and their susceptibility to political pressure to pursue other goals.

For all these reasons, it seems clear to me that the increased transparency that would be provided by an explicit long-term inflation objective would increase the probability that we will attain our goal over time. Some argue strongly for a dual objective that refers explicitly to output or employment as well as inflation. But both theory and experience indicate that the Fed cannot control real variables directly with monetary policy, and in my view there are reasonable grounds to presume that the Fed will optimize its contribution to the economy's overall performance by maintaining credibility for low inflation.[4] A unitary goal focused on low inflation would strengthen credibility by making the Fed's commitment to this objective definite and unambiguous.

It is one thing to advocate an explicit inflation objective; it is another to actually put one in place. I doubt seriously that an explicit objective set and announced unilaterally by the Fed would be credible. Any explicit inflation objective would need to be accepted by the government as a whole through legislation or some other formal agreement, as such objectives are in countries that employ them. With its public standing high, the Fed seems well positioned currently to make the case for such a mandate.

2. INTERMEDIATE-TERM ISSUES

Even if the Fed obtains a price stability mandate, transparency issues are still likely to arise in practice—specifically, when current inflation or near-term inflation projections deviate from the long-term objective. For example, inflation may rise above its objective at a time when real output is below potential and unemployment is rising. It would be difficult or impossible in this situation for the Fed to ignore the weakness in the real economy and act aggressively to bring inflation quickly back to target.

[4] See Goodfriend and King (2001).

Some have argued that precisely this possibility makes an explicit inflation objective for the United States impractical. I don't find this objection particularly compelling. Especially if the Fed has previously established credibility, inflation may remain above its objective for some time without undue damage to the Fed's credibility if the Fed is transparent regarding its medium-term strategy for bringing inflation back to path. Even with established credibility, explaining this strategy clearly and convincingly to market participants and the general public would be challenging. Strategies and the accompanying explanations will have to be tailored to each case. In particular, the Fed may anticipate bringing inflation back to the objective more quickly in some cases than in others. Consequently, it may be useful for the Fed to announce intermediate-term inflation forecasts to assist the public in making financial and business decisions during the transition back to the long-term objective.

Beyond this, even if inflation is stable at or near its long-term objective, unanticipated shocks may push employment and output growth temporarily away from their sustainable noninflationary rates. Here, too, Fed transparency about its intentions will help the public gauge how production, employment, and interest rates will evolve in the medium term as the economy adjusts to the shock. Transparency is in the Fed's interest as well since it can help build confidence that, first, monetary policy can be effective in dealing with temporary departures of real activity from its long-term potential, and, second, that the Fed has the competence to exploit this capability. More generally, I believe that the Fed's expertise regarding the functioning of the U.S. economy—while far from perfect—is now of high enough quality that transparency of our thinking about the economy's medium-term prospects can build public confidence and trust in periods of economic stress. To be sure, actual developments may deviate from our announced expectations in particular situations, but trust can be maintained if the Fed provides reasonable explanations for the deviations.

3. TRANSPARENCY OF THE FEDERAL FUNDS RATE TARGET AND THE DIRECTIVE "TILT"

Having dealt with longer-term and intermediate-term issues, let me now make a few comments about transparency as it relates to short-term policy tactics: specifically, transparency regarding the current Federal funds rate target, the "tilt" of the directive language, and the statement released to the press after each Federal Open Market Committee (FOMC) meeting. It is in this area that the greatest progress has been made in increasing transparency over the last decade. The funds rate target set at a particular FOMC meeting, previously released only after the next FOMC meeting, since February 1994 has been

announced shortly after adjournment of the meeting where it is set. So, markets now know the current target. And the Committee has released the tilt (or absence of a tilt) in the directive language along with the current funds rate target since its meeting on May 18, 1999. Previously, it too had been released only after the next FOMC meeting.

This increased instrument transparency, in my view, is all to the good. I believe the immediate release of the tilt language is especially useful. Again, the effect of monetary policy is transmitted to the economy not only through the current level of the funds rate target but also through market expectations about the *future* level of the target, which are reflected in the short-term yield curve. Market participants are going to form these expectations in any event. By announcing the tilt immediately, the FOMC shares its best current estimate of the most likely direction of any near-term change in the funds rate target, which should increase the efficiency with which markets form their expectations, help prepare markets and the public for changes in the target, and reduce short-term disruptions caused by leaks. In particular, since markets know the current tilt, they are better positioned to interpret the likely policy implications of incoming current economic data. For example, the release of strong data after disclosure of an upside tilt in the directive language should increase the probability that long-term rates will be bid upward in response. Consequently, immediate disclosure of the tilt should enable long-term interest rate adjustments to perform their stabilizing role in the economy more effectively.

While, again, considerable progress has been made in increasing the transparency of the Fed's short-term instrument settings, and its short-term expectations regarding at least the direction of future settings, there is room for further progress in my view. In particular, there may be different views about the extent to which a tilt in the directive in one direction or the other commits or obliges the Fed to a future funds rate change. To the degree that markets interpret a tilt as committing the Fed to future action, failure to take action may surprise or "whipsaw" markets. It should be possible for the Fed to mitigate this problem by emphasizing publicly that a tilt only implies a greater likelihood that any near-term change in the funds rate will be in a particular direction and is not a commitment to any action. It might seem tempting to consider eliminating the tilt in the formulation of short-term policy to remove any confusion it may produce. But such a reduction in transparency would deprive the FOMC of the benefits of announcing the tilt noted above. Moreover, beyond these benefits, abandoning it would deprive the Committee of a useful way to keep in touch with the strength of its internal consensus regarding policy at any point in time and of a valuable supplementary tool for reaching agreement on a funds rate target when there is a significant divergence of views regarding the appropriate level of the target.

Finally, it is important to recognize that the language of the press statement announcing the funds rate target and any tilt after each meeting also influences market expectations regarding future policy actions. This language is widely reported and interpreted currently in media coverage of FOMC meetings. In essence, the language in the statement, like the tilt language in the directive, is viewed by market participants as an additional short-term policy instrument.

4. TESTIMONY AND SPEECHES

The role of the Fed's explicit policy announcements in shaping market expectations of future policy actions is obviously important, but as anyone even slightly interested in Fed policy is well aware, public statements by individual FOMC members (including Reserve Bank presidents who are not currently voting Committee members) are at times especially important. This is particularly so in today's environment where media coverage of these utterances by cable television financial news channels, instant e-mail transmission of market analysis, and the like are much more extensive than even just a few years ago. Obviously, the Fed Chairman's remarks in congressional testimony (including answers to questions as well as prepared testimony), his speeches, and his interviews are followed more intensely than the comments of other FOMC participants since the Chairman is clearly the most influential Committee member and only he speaks for the Committee as a whole. At times, however, comments of other participants can affect market expectations, at least in the short run, if, for example, a comment is the Fed's first public reaction to a new economic report (particularly if the content of the report was unanticipated by markets), or the comment comes at a time when markets are especially uncertain about near-term policy prospects. Consequently, we also receive our share of media attention. Bill Poole, I, and, I expect, all of our colleagues at other Reserve Banks can tell stories about being covered by several reporters even when making speeches in fairly remote parts of our respective districts.

Some argue that this form of Fed transparency may be counterproductive, at least at times, if the views expressed in these comments seem inconsistent—particularly if they appear to conflict with a recent FOMC decision or a public statement by the Chairman. On occasion I have personally received criticism and complaints from market professionals and others when they have found my statements at variance with other Fed statements or confusing in some other way, and I will acknowledge that on a few occasions my remarks may have briefly complicated the formation of market expectations.

Over time, however, speeches and other public statements by individual FOMC participants provide markets and the public with a more robust and complete understanding of thinking inside the Fed about current economic

and financial conditions and near-term prospects than that provided by the policy announcements I discussed a minute ago alone. Also, it is important to recognize that market analysts are adept at filtering and appropriately weighting press reports of individual FOMC participant remarks in the context of the broad range of Fed public statements from all sources. In short, I believe a convincing case can be made that the public remarks of individual Reserve Bank presidents and other FOMC participants increase the efficiency with which markets form short-term policy expectations.

I would offer one other—admittedly speculative—note on this point. It is obvious, again, that the Fed Chairman speaks with by far the most influential voice among FOMC participants. It might appear superficially that comments by other participants that seem to be "off message" might create confusion about the Fed's intentions and undermine the force of the Chairman's statements. As I just suggested, there might be a little of this from time to time, but I doubt these instances are of much significance. Again, markets are well aware of the much greater weight of the Chairman's statements and discount the remarks of other FOMC participants accordingly. Perhaps more importantly, public commentary by other participants reinforces the Chairman's credibility in the eyes of informed observers of Fed policy since it demonstrates that the Chairman leads, builds consensus among, and speaks for a thoughtful, competent group of policy professionals who naturally have diverse views on specific policy choices. If the public believed the Chairman was conducting policy unilaterally, he or she would be more vulnerable to an abrupt loss of public confidence. This might not be a risk for the current Chairman, who justifiably enjoys exceptionally high public respect, but it could be a problem for a future Chairman.

5. CONCLUSION

Again, I have enjoyed participating in this panel discussion. This conference has addressed what is clearly a crucial topic in understanding how monetary policy affects the economy and how it might be improved. The subject deserves continued research. Thanks to this conference, I am confident it will get it.

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The Growth of Unsecured Credit: Are We Better Off?

Kartik Athreya

The growth in unsecured credit over the past two decades has, because of current bankruptcy law, reduced the average welfare of the poor. This striking conclusion emerges from a model designed to maximize the benefits of both plentiful unsecured credit and lax bankruptcy law. Even exclusive concern for wealth redistribution does not provide self-evident justification for lax bankruptcy law in the face of the unprecedented expansion in unsecured credit occurring over the past two decades. Specifically, according to the model, the welfare of low-income, low-asset households appears to have fallen in response to the dramatic increase in the availability of unsecured credit that has occurred since the *Marquette* Supreme Court ruling in 1978. The driving forces behind this welfare decrease are, first, the role of lax personal bankruptcy law in thwarting debtors from credibly committing to repay debts, second, the premium that the poor must pay to borrow on unsecured credit markets, and third, the welfare loss from the imposition of deadweight bankruptcy penalties. Before discussing the model in greater detail, I will turn to a brief history of unsecured credit and personal bankruptcy in the United States.

The Supreme Court ruling in 1978 in the case of *Marquette National Bank of Minneapolis v. First of Omaha Service Corporation,* 439 US 299 (1978) was a watershed. This ruling against Marquette National Bank allowed a bank in nearby Nebraska, First of Omaha, to issue loans to residents of Minnesota at rates higher than the ceiling in effect in Minnesota; the maximum rate allowable in Nebraska was higher. Marquette argued that allowing First of Omaha to export loans to Minnesota would undercut Minnesota's usury

I thank Beth Anderson, Marvin Goodfriend, Tom Humphrey, John Walter, and John Weinberg for very helpful comments and criticisms that have greatly improved this paper. I am particularly indebted to Jeff Lacker and Joseph Pomykala for their extremely thorough comments. The opinions expressed in this article are those of the author and do not necessarily reflect those of the Federal Reserve Bank of Richmond or the Federal Reserve System.

restrictions. The Supreme Court saw otherwise and ruled that First of Omaha was within its rights to issue loans at rates exceeding Minnesota's ceiling. This ruling was critical to the growth of an organized unsecured credit industry in the United States, as it suddenly made a relatively risky form of lending profitable. Within two years, credit card lenders including Citibank and MBNA moved to states with the highest interest rate ceilings, such as Delaware and South Dakota, and began nationwide operations.

Since the 1978 ruling, low-income households in particular have seen their access to uncollateralized credit grow dramatically, principally via credit cards. The growth of this credit market enhanced the ability of U.S. households to deal with individual-specific and economywide risks by *conveniently* allowing them to borrow more when times are bad. The credit card industry, in particular, expanded enormously because lenders were given the opportunity to offer uncollateralized loans and short-term credit to those with little tangible wealth. This expansion of unsecured credit mainly affected borrowers with low tangible wealth. Others could credibly commit to repaying loans via collateral, making usury laws a non-issue. Those who could not credibly commit to repayment were most likely to be deemed unprofitable risks at interest rates below the usury ceiling.

Personal bankruptcy law has a major impact on the ability of unsecured borrowers to commit to repayment of loans. While intended to provide insurance against misfortune, these rules have the perverse effect of preventing borrowers with little collateral from promising to repay a loan. Those who hold collateral can and do avoid the constraints of bankruptcy protection and face lower borrowing costs as a result. Those with collateralizable wealth also obtain all the transactions benefits of credit cards without facing the annual fees and relatively low credit limits typically imposed on low-income credit card users. Therefore, the inability to commit to repayment even affects the distribution of pure transactions cost benefits made possible by recent rapid advances in payment card technology.[1]

The growth in unsecured credit has been accompanied by an unprecedented rise in personal bankruptcy, thereby making bankruptcy law relevant to welfare. The level of recent filings, currently greater than 1 percent of all U.S. households, has led to calls for more stringent law by some, but has been defended by others. The proponents of strict bankruptcy law argue that plentiful unsecured credit and lax bankruptcy law give debtors an easy way out.[2] Opponents argue that bankruptcy and easily available unsecured credit are like insurance and are therefore part of a larger social safety net. Both arguments

[1] Very recently, the advent of debit cards/check cards has helped high-risk borrowers obtain transactions benefits without paying the fees intended to reveal their risk profile.

[2] See, for example, the contrasting remarks of Senator Charles Grassley (R-Iowa) and Senator Paul Wellstone (D-Minn.) in congressional testimony on the Bankruptcy Reform Act of 2000. The complete discussion is available at www.abiworld.org/debate/127.htm.

contain some truth, and it is therefore certain that the welfare gains from the increased availability of unsecured credit and additional implicit insurance available through bankruptcy are tempered by a default premium.[3]

The question we must ask, then, is the following. What is the net benefit or cost of the rapid expansion in unsecured lending that has taken place following the *Marquette* ruling? This question, first posed over a decade ago in the seminal and prescient work of Sullivan, Warren, and Westbrook (1989), has since gone unanswered.

To the extent that bankruptcy provides additional all-purpose insurance to American households, the rising rate of filings may simply represent a wider group of borrowers cashing in an implicit insurance policy. This policy, in turn, is priced appropriately by increased default premiums in loan rates. From this perspective, the rising level of filings may not be anything to worry about.[4] Those arguing for tighter personal bankruptcy law must show that the very option of easy bankruptcy retards the ability of households to tide over fluctuations in their incomes by making borrowing excessively expensive, or that easy bankruptcy lowers welfare by necessitating the frequent use of socially costly "deadweight" penalties. In what follows, I demonstrate that both of the preceding arguments can be made for U.S. households.

There has been no shortage of opinions on the impact of easy credit and bankruptcy on the poor in recent times.[5] Unfortunately, these views are typically based on anecdotal evidence or static empirical approaches. Such approaches typically cannot quantify the complex interactions between the widespread availability of credit, the bankruptcy system, the behavior of households trying to smooth temporary fluctuations in their income and employment, and the interest rates they pay to borrow. This article presents a simple, unified analysis of how changes in unsecured credit interact with bankruptcy law to affect consumer welfare. The framework provides a preliminary assessment of the net effects of the post-*Marquette* revolution in unsecured credit and the attendant revolution in personal bankruptcy.

The expansion of credit to low-income households and bankruptcy protection is most often defended as helping to protect the poor against bad luck and unscrupulous creditors. Therefore, this article stacks the deck in favor of generating a positive role for expanded unsecured credit and lax bankruptcy.

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[3] By "default premium," I am referring to the high interest rates paid by borrowers on the unsecured market relative to those paid by secured borrowers, as with home equity loans.

[4] An analogy can be seen as follows. In general, we do not question the appropriateness of allowing people to purchase hurricane insurance when we see people collecting on their policies after a hurricane. Perhaps the insurance feature embedded in bankruptcy is no different, but if not, why?

[5] See *The Washington Monthly* (March 1997), and, again, the testimony of Senator Charles Grassley (R-Iowa) and Senator Paul Wellstone (D-Minn) at www.abiworld.org.

To this end, I make three assumptions, discussed in detail later, that are designed to maximize the benefits of lax bankruptcy law as a means of wealth redistribution from the rich to the poor.

Surprisingly, despite such assumptions, the existing combination of easily available unsecured credit and current bankruptcy law is found to *reduce* welfare relative to the environment of tighter unsecured credit that prevailed before 1978. The real welfare loss comes from a subset of low-income, low-wealth households being prevented by bankruptcy law from credibly committing to repaying loans. One possible remedy is therefore to allow individuals to pre-commit to debt rescheduling instead of being forced into Chapter 7 liquidation.[6] The model also strongly suggests that U.S. households are actually less inclined to file for bankruptcy, all else equal, since the increase in filings is well accounted for by an increase in credit availability to low-income households. Therefore, contrary to the popular view, the stigma associated with bankruptcy appears to be as strong as ever.[7]

1. *MARQUETTE* AND UNSECURED CREDIT

By making large-scale uncollateralized lending commercially feasible, at least in principle, the *Marquette* ruling set the stage for overcoming a "chicken-and-egg" problem facing payment cards in general and credit cards in particular. That is, how could an industry establish a large, smoothly functioning payment system when consumers would only hold a card that was widely accepted and merchants would bear the costs of entering the given payment network only if they felt that cardholding would expand sufficiently? As Evans and Schmalensee (1998, p. 72) argue, "less balkanization of state credit restraints set the stage for the marketing of payment cards on a nationwide basis. . . [and] by permitting a national market, *Marquette* probably enabled issuers to realize scale economies in marketing and processing costs, and thus to make payment cards more readily available to consumers across the country."[8] At the same time that the construction of a payments network began, a revolution in credit risk management in the form of "credit scoring" was underway. Credit scoring enabled credit issuers to predict fairly precisely overall losses on a large nationwide portfolio of cardholders while remaining probabilistically uncertain about the repayment behavior of any given cardholder. Credit scoring is an

[6] Unfortunately, the difficulties associated with credible opt-out are daunting. In particular, Section 362 in the bankruptcy code makes opt-out essentially unenforceable (personal communication with Professor Joseph Pomykala, July 27, 2001).

[7] Bankruptcy stigma is defined as feelings of guilt and shame and dispproval from others.

[8] Although I will maintain the assumption of competitive credit markets throughout, the following caveat is warranted. To the extent that *Marquette* removed the last vestiges of market power by eliminating regional segmentation of credit market, the negative welfare consequences presented here may be somewhat moderated.

instrumental feature of today's credit market, and has allowed better pricing and increased availability of credit for all consumers, including those as seen as "risky."[9]

The interest rate ceilings in place prior to *Marquette* appear to have greatly limited the growth of this credit market. Canner and Fergus (1987) provide a careful empirical analysis of the likely effects of Senate bills S.1603 and S.1922. Each of these bills was aimed at imposing nationwide interest rate ceilings. Canner and Fergus argue that existing interstate variation in interest rate ceilings indicates that consumers in states with low ceilings face greater difficulty in obtaining loans and would suffer if nationwide ceilings were implemented. Their arguments are further buttressed by Villegas (1989), who cites evidence from the 1983 Survey of Consumer Finances that restrictive interest rate caps lower the availability of credit to high-risk borrowers, often those who are poorest.[10] Also suggestive is the dramatic increase in the number of credit cards held by U.S. households beginning in the period immediately following *Marquette*. In 1981, there were 572 million credit cards outstanding, and by 1987, this number had risen to 841 million. Lastly, the detailed empirical analyses of Evans and Schmalensee (1999), Black and Morgan (1999), Moss and Johnson (2000), and Ellis (1998), provide clear accounts of the disproportionately rapid increase in unsecured credit availability among those with low incomes. Given the preceding, a maintained hypothesis of this article is that the increased availability of commercial unsecured consumer credit did not simply displace existing informal credit arrangements, but substantially relaxed the liquidity constraints faced by poor households.

2. BANKRUPTCY FACTS

I will now briefly document the revolution in personal bankruptcy filing rates that has accompanied the revolution in unsecured credit. While business filings remained a negligible and steady fraction of the total number of bankruptcies, non-business filings have increased dramatically. First, as seen in Figure 1, total non-business filing rose from roughly 250,000 filings in 1980, just after the *Marquette* ruling, to roughly 1.3 million in each year from 1997 to 2000.[11] This is an increase in filing rate from roughly 1 in 400 households to more than

[9] See Evans and Schmalensee (1998, pp. 95–97, 251).

[10] See also *The Economist* (November 1998), which details the stark differences in credit availibility on either side of the border town of Texarkana. On the Texas side, lending and purchases of consumer durables flourishes, while it stagnates on the Arkansas side.

[11] 2001 is already on pace to break all previous records, with the second highest number of filings ever recorded in the first quarter. Source: American Bankruptcy Institute, www.abiworld.org.

1 per 100 households.[12] The volume of debt discharged in these bankruptcies had grown to roughly $40 billion in 1997, 1998, 1999, and 2000.

The losses above arose primarily from what are known as Chapter 7 bankruptcies. A Chapter 7 filing removes all unsecured debt from the debtor's balance sheet in exchange for all "nonexempt" assets that are held by the household. Of the 1.4 million bankruptcies in 1997, over 70 percent—nearly one million filings—were Chapter 7 filings. The average debtor in a Chapter 7 bankruptcy defaulted on an average of $35,000 in 1997.[13] Chapter 7 filings alone led to losses of $36.4 billion. Although Chapter 13 bankruptcies essentially reschedule secured debts, and therefore result in very low losses of secured debt relative to Chapter 7 bankruptcies, they still result in the discharge of most unsecured debt. For example, in a study by Wharton Econometric Forecasting Associates (WEFA), in 1997, approximately 90 percent of the $6.5 billion in total unsecured debt in Chapter 13 bankruptcy was not repaid. For the purposes of this article, my focus will be on unsecured debt; therefore, I do not distinguish between Chapter 7 and Chapter 13 filings.

With respect to the identity of the filers described above, note first that the income gap between bankruptcy filers and average households reflects a systematic difference in occupational structure as well as education levels. Luckett (1988) finds that bankruptcy occurs most often among low-income individuals working in unskilled occupations.[14] Empirically, the link between low-mean income and high volatility is documented clearly in Kydland (1984) and will be the basis for my parameterization of labor income risk.

A large portion of bankruptcies result from the disruption of labor income due to job loss, sickness, or other factors.[15] In their landmark study, Sullivan, Warren, and Westbrook (1989) find that roughly 80 percent of bankruptcy filers in their 1981 sample reported an income change in the two years previous to filing. Of these, 62 percent had experienced a change in income of greater than 10 percent over the previous year, and of those whose income fell, the mean decline was 37.2 percent![16] Additionally, Sullivan, Warren, and Westbrook find that the median and mean incomes in their sample of bankruptcy filers

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[12] The median state in the United States had almost exactly one filing per 100 households in 2000. Source: American Bankruptcy Institute.

[13] Culhane and White (1999).

[14] Interestingly, Sullivan, Warren, and Westbrook (1989) also find that while the mean incomes of bankrupts are lower than average, the distribution of these workers by industry across the labor force mirrors that of the general population.

[15] See Sullivan, Warren, and Westbrook (1989, pp. 95–101, 187).

[16] To quote Sullivan, Warren, and Westbrook (1989), "these figures portray highly volatile income streams, making a mismatch between debts and income likely."

To be more precise, what is true is that a "mismatch" between debts and income is more likely *conditional* on a level of debt. However, the level of debt taken on by a household depends, among other things, on income volatility and bankruptcy law. Therefore, the *unconditonal* likelihood of a mismatch may or may not be more likely.

were both roughly two-thirds that of the average household. It is clear therefore that unsecured debt and bankruptcy protection together form an all-purpose insurance policy against the hardships caused by volatile and low incomes.[17]

Bankruptcy is not, however, an insurance policy given to households for free. Beyond increased interest rates on unsecured loans, there are four types of costs to the debtor associated with bankruptcy. First, and most importantly, bankruptcy results in at least some exclusion from credit markets. Second, there are costs associated with the surrender of nonexempt assets, and, more rarely, with possible future wage garnishments. Third, stigma appears to play a role (see Fay, Hurst, and White [1996] and Gross and Souleles [2000]). Finally, although they are usually small, there are explicit costs, such as those such as those arising from court dates or lawyer's fees.

In practice, bankruptcy almost never involves the transfer of assets or income from debtor to creditor. Over 95 percent of Chapter 7 bankruptcies are "no-asset" cases.[18] Almost all bankruptcy penalties levied on debtors filing for bankruptcy therefore constitute deadweight losses. Deadweight costs are important for two reasons. First, by construction, bankruptcy is typically used only by those who do not have a great deal of material wealth. Second, even when debtors have wealth at the time of filing, it is often difficult to seize it in the presence of various exemptions. Therefore, the only remaining route to arrange transfers from borrowers to lenders is via wage garnishing, which is rarely used.[19] The inability to seize future income further requires that the vast majority of penalties for bankruptcy be those involving punishment of the borrower *without* wealth transfers to the lender. The reliance on deadweight penalties clearly hinders the ability of bankruptcy to function as a welfare-improving, risk-bearing institution. This is an important part of the arguments for stricter, but finite, penalties for bankruptcy (see Dubey, Geanakoplos, and Shubik [2000]).

I turn now to a description of formal economic environments in order to study the consequences of alternative credit market arrangements, with specific reference to the growth of unsecured credit availability among lower-income households.

[17] Such volatility may understate the full risk faced by the uninsured, as illness can cause shocks to expenses as well as income.

[18] See Sullivan, Warren, and Westbrook (1989, pp. 201–18).

[19] See again Sullivan, Warren, and Westbrook (1989, pp. 22–24). In particular, bankruptcy also stops garnishments.

3. A MODEL OF UNSECURED CREDIT AND BANKRUPTCY

My model is specifically aimed at understanding the welfare, price, and quantity consequences of the dramatic change in the distribution of unsecured consumer credit over the past two decades.

Preferences

There is a continuum of infinitely-lived agents with constant relative risk-aversion (CRRA) preferences. This standard formulation captures risk aversion, the desire for smooth consumption, and the concern households have for future generations. The parameter $\beta \in (0, 1)$ indicates the rate at which future consumption is discounted, and the parameter α indicates the risk aversion, as well the desire for smooth consumption over time. Expected lifetime utility is given by

$$E_0 \sum_{t=0}^{\infty} \beta^t \frac{C_t^{1-\alpha}}{1-\alpha},$$

where c_t is consumption at time t.

Labor Income

There are two types of agents who will receive systematically different incomes over time. These differences are meant to capture the higher average income and lower income risk faced by skilled individuals. I further assume that the type of a household is unobservable to a lender. This assumption is plausible because credit reports do not contain labor income, other than self-reported measures *at the time of application*.[20] The type of household is denoted by $i \in I$, where $i = h$ indicates high average income households and $i = l$ indicates low-income households. The proportion of high-income agents in the population is denoted by ω, and low-income agents represent the remaining fraction $(1 - \omega)$ in the population. Labor income i is denoted by $\widetilde{Y}^i$ and can take on two values, Y_g^i and Y_b^i. The subscripts g and b denote income in the good and bad states respectively, and $Y_g^h > Y_g^l$ and $Y_b^h > Y_b^l$. Let mean income for type-l and type-h households be given by $\overline{Y}^l$ and $\overline{Y}^h$, respectively. Labor income also evolves smoothly over time in the sense that current (annual) income is helpful to an individual for estimating future income. I denote by p_{gg}^i the probability that income next period is good if income this period is

[20] While it is true that a borrower may reveal some information on his or her type via serious deliquency behavior, this is typically too late for risk managment purposes. See Sullivan, Warren, and Westbrook (1989, p. 187) for more.

good. The probability of staying in the bad income state is given by p^i_{bb}. The forecastability of future income allows agents to plan savings or borrowing to keep consumption smooth.

Consumer Debt, Savings, and Intermediaries

Despite the large levels of default, the market for unsecured credit in the United States does function smoothly, and it is well characterized as a large competitive marketplace where price-taking lenders issue credit through the purchase of securities backed by repayments from those who borrow.[21] These transactions are intermediated principally by credit card issuers. The interest rates charged by credit card issuers are not individually tailored for each account but instead cover the aggregate default rate. The typical credit card contract is described by a fixed interest rate and credit line. Interest rates are typically rather insensitive to changes in individual debt levels, even though the marginal likelihood of default may change.

Given the preceding, I assume that in order to smooth consumption, agents have access to competitive markets wherein they may borrow or save assets. An agent's financial wealth is denoted a_t, where $a_t > 0$ represents saving and $a_t < 0$ represents borrowing. Agents may borrow at the going interest rate on loans $(1 + r^l)$ or save by holding deposits at the interest rate $(1 + r^d)$. Note that the interest rate on loans does not vary with an agent's type, income, or current wealth level. This invariance reflects an assumption that lenders are unable to differentiate between households. Each agent of type i faces a borrowing limit $\underline{A}^i$.[22] Borrowing limits play a central role in the model, and I will study outcomes arising from a variety of values for them.

Bankruptcy in the Model

Bankruptcy works in the model as follows. When an individual files, his or her debts are removed and he or she is then penalized in two ways. First, an agent is prevented from borrowing (i.e., is borrowing constrained) for an uncertain length of time, although the average length of this period, ρ, is known to the agent. During this period of exile from loan markets, agents may still save to meet contingencies. After this time, they may borrow freely

[21] A strong case can be made for the appropriateness of this characterization. See Evans and Schmalensee (1999) and the references therein. Lest one think that lax bankruptcy would be obviously desirable if the credit card industry were monopolistic, note that the brunt of high borrowing costs for unsecured credit are borne not by the wealthy, who have cheaper secured borrowing available to them, but by the poor and those with low collateralizable wealth. Therefore, the competitive assumption may actually make lax bankruptcy law easier to defend.

[22] As with incomplete insurance contracts, borrowing limits (the rationing of credit) can be derived from more primitive assumptions on the structure of information possessed by lenders and borrowers. We avoid this complication here and directly assume credit limits.

and are considered solvent. Agents in the borrowing constrained state are probabilistically returned to credit markets, whereby with probability $1/\rho$ they are returned to solvency (i.e., they are free to borrow and default in the following period), and with probability $(1 - 1/\rho)$ they are still restricted from borrowing or defaulting.

The second feature of bankruptcy in the model is that the filer is penalized in the ways discussed earlier. However, given that these penalties do not involve resource transfers, and given that the sum of these various penalties governs behavior, I employ a penalty levied directly on utility. I use λ^i to denote all costs of bankruptcy, in terms of utility, to a type-i household beyond those costs accruing directly from credit market exclusion; this includes legal fees and the psychic costs of stigma.

The combination of easily available unsecured credit and lax personal bankruptcy law is often seen as beneficial for the unlucky poor against the ravages of bad luck and greedy creditors. In order to give this view its best day in court, I proceed as follows.

Assumption 1 *Only low-mean income agents will choose to file for bankruptcy.*

Assumption 1 simply assumes that the cost of bankruptcy to high-mean income households is so high that they never declare bankruptcy. As was argued earlier, this assumption is supported by the evidence that filers have systematically lower paying occupations than non-filers (see again Sullivan, Warren, and Westbrook [1989]). Assumption 1 blunts the argument that we should tighten bankruptcy law to defend the poor from the excesses of the rich; this argument is frequently heard from proponents of tougher law whenever a high-profile case of bankruptcy surfaces.[23]

The Consumer's Choice Problem[24]

The consumer's choice problem is most naturally expressed recursively. Specifically, at a point in time an agent can be solvent (denoted S), bankrupt (denoted B), or borrowing constrained (denoted BC). The value to an agent of having a given level of current income, asset holdings, and credit market status (borrowing constrained or solvent) can be expressed in terms of utility from choices over current consumption/savings and credit market status (if solvent) and the expected future value of those choices. I restrict borrowing according to an agent's credit status as follows. For solvent agents of type

[23] As in the cases of the actor Burt Reynolds and former Commissioner of Major League Baseball Bowie Kuhn.

[24] This section and the following section defining equilibrium may be skipped by those primarily interested in the results.

i, net assets must be greater than the borrowing limit, $\underline{A}^i_S$, and for borrowing constrained agents, $\underline{A}^i_{BC}$. There are no restrictions on savings.

Each period, given their current income and beginning-of-period assets, agents must choose consumption, c, and asset holdings, denoted a', to carry forward into the next period. Depending on whether they choose to be net borrowers or lenders, they face either the net rate of interest on loans r^l or on deposits r^d, where $r^l > r^d$.

When an agent is solvent and qualifies for bankruptcy protection, he or she must first choose whether or not to file and then choose assets subject to the constraints for solvent or borrowing constrained agents, depending on their default decision. I now introduce two pieces of notation. First, the vector (a, y) is an agent's current period state conditional on credit status. With this notation, the value of being solvent V^i_S is given as follows.

$$V^i_S(a, y) = \max[W^i_S(a, y), W^i_B(a, y)], \tag{1}$$

where W^i_S denotes the value of *not* filing for bankruptcy in the current period, and satisfies

$$W^i_S(a, y) = \max\{u(c) + \beta E V^i_S(a', y')\}$$

s.t.

$$c + \frac{a'}{1 + r} \leq y + a \tag{2}$$

$$a' \geq \underline{A}^i_S, \tag{3}$$

where r is understood to be the interest rate on loans r^l if assets are negative and the rate on deposits r^d if assets are positive.

Bankruptcy is relevant to only those with debts, i.e., to households with assets $a < 0$. When the agent files for bankruptcy, he or she has his or her debt removed, pays the cost of bankruptcy, λ^i, and is sent with *probability one* to the borrowing constrained state, where he or she obtains value V^i_{BC}. Therefore, the value of filing for bankruptcy, denoted W^i_B, satisfies

$$W^i_B(a, y) = \max\{u(c) - \lambda^i + \beta E V^i_{BC}(a', y')\}$$

s.t.

$$c + \frac{a'}{1 + r^d} \leq y \tag{4}$$

$$a' \geq 0. \tag{5}$$

To define V^i_{BC} above, note that agents in the borrowing constrained state are probabilistically returned to credit markets, whereby with probability $1/\rho$, they are returned to solvency (i.e., they are free to borrow and default in the following period), and with probability $(1-1/\rho)$, they are still restricted from borrowing or defaulting. Let $\psi \equiv 1/\rho$. Thus,

$$V^i_{BC}(a, y) = \max\{u(c) + \psi\beta E V^i_S(a', y') + (1-\psi)\beta E V^i_{BC}(a', y')\}$$

s.t.

$$c + \frac{a'}{1+r^d} \leq y^i + a, \tag{6}$$

$$a' \geq \underline{A}^i_{BC}. \tag{7}$$

I turn now to the definition of equilibrium in the model.

Equilibrium

The consumer choice problem above captures the decisions of a very large number of households. However, given the absence of perfect income insurance, households who have received many bad income shocks are likely to find themselves in debt, while those who have been lucky will hold perhaps large levels of savings. Their choices are governed by a *decision rule*, which, for a household of type i, specifies asset holdings as a function of interest rates, income, current assets, and borrowing constraints.

An equilibrium consists of a decision rule for each type of agent and interest rates r^l and r^d such that four requirements are met. First, given these interest rates, decision roles are optimal and feasible. Second, total economywide borrowing by households equals total economywide saving. Third, I restrict attention to steady state equilibria where the bankruptcy rate Π and fraction of agents in the population with a given level of assets are stationary, i.e., the same at every date. Fourth, I require that the spread between loan and deposit rates is such that financial intermediaries exactly cover their costs, given the observed bankruptcy rate.

Parameterization

The assumption of stationarity implies that the analysis here is appropriate as a study of two different long-run situations, one in the pre-*Marquette* era and one currently prevailing. The relatively flat bankruptcy rate over the past four years suggests that at this point in the post-*Marquette* era we may have attained a new steady state. Given the preceding, the overall strategy is as follows. I will first choose a set of parameters such that the equilibrium outcomes match

salient features of the pre-*Marquette* environment. In particular, I will set the parameters to match bankruptcy filing rates in the pre-*Marquette* era. I will then choose alternative values for the nonpecuniary costs of bankruptcy, credit limits, and the parameter governing the average period that bankrupt borrowers are excluded from the credit market, such that the model matches outcomes in the post-*Marquette* world.

I am assuming that the post-*Marquette* expansion in bankruptcy rates resulted from the increased ease with which borrowers who declare bankruptcy are able to borrow again, along with an increase in borrowing limits and a reduction in the costs of filing for bankruptcy, notably in terms of stigma.

All other parameters will remain fixed in both the pre- and post-*Marquette* eras and are set to match certain statistics concerning income risk in the United States. Specifically, the income processes are set to match observed persistence and volatility by skill level, along with the observed skill-premium, and are summarized in Table 1. For brevity, I do not give exhaustive details on these parameters, but rather refer the interested reader to the detailed discussions in Athreya (2000a,b), as well as to Kydland (1984), Heaton and Lucas (1997), and Autor, Katz, and Kreuger (1998).

The welfare criterion used here measures the percentage change in consumption, at all dates, that would make a household indifferent between the pre- and post-*Marquette* eras. This increment/decrement to consumption is denoted by ϕ. A negative value for ϕ implies that households are worse off in the post-*Marquette* era, and a positive value implies the reverse. With respect to the policies chosen by a society, if it turns out that the welfare of low-income agents improves significantly under lax bankruptcy law, even if that of high-income people worsens significantly, such a law may still be chosen. Given this, Assumption 2 is the following.

Assumption 2 *Low-mean agents matter at least as much as high-mean agents in measuring welfare.*

I also assume that even though only low-mean income agents go bankrupt, creditors are unable to distinguish them from high-mean income borrowers. That is:

Assumption 3 *Creditors are not able to price-discriminate between high- and low-mean agents.*

This assumption implies the spreading of default costs not just across the low-mean, high-volatility group, but across all high-mean agents as well. It is in exactly this way that bankruptcy can redistribute wealth from rich to poor.[25]

[25] See Sullivan, Warren, and Westbrook (1989, p. 187) for evidence that this is an appropriate assumption.

By combining Assumptions 2 and 3 with Assumption 1, I effectively allow for the most generous possible redistribution from high-mean income people to low-mean income people.

Credit Market Exclusion

An important parameter in the model with respect to bankruptcy is the period of credit market exclusion, ρ. While ρ is not easily observable, an upper bound is ten years—the length of time for which bankruptcy remains on a credit record. In current times (the post-*Marquette* era), the restriction on future borrowing, denoted ρ_{post}, is certainly less than ten years, as evidenced by the growth of sub-prime lending. Lenders in this market, while typically more expensive than credit card lenders, still allow agents access to loan markets following default or bankruptcy within a year or two. I err on the side of strictness in the penalty and set ρ_{post} such that the average period of exile from credit markets is four years. However, in the pre-*Marquette* era, exile for a period of ten years may have been a reasonable estimate for the restriction on borrowing. I therefore fix the pre-*Marquette* exile parameter ρ_{pre} to imply an average exile period of ten years.

Nonpecuniary Costs and the Bankruptcy Rate

The parameters λ^i will be inferred by the level that it must take in order to match observed bankruptcy filing rates in the pre- and post-*Marquette* eras, given the applicable credit market penalties and credit limits. Assumption 1 simply requires that λ^h be set such that no high-mean income households files for bankruptcy. The cost for low-mean income households, λ^l, is set to match pre-*Marquette* filing rates and is then used in the post-*Marquette* era, where it will be denoted λ^l_{fixed}. When λ^l is reestimated in order to match the filing rate in the post-*Marquette* era, it will be denoted λ^l_{endog}.

In terms of bankruptcy rates, in 1978, the year of the *Marquette* ruling, roughly 300,000 filings occurred in a 76 million household economy, which implies a national filing rate of 0.4 percent.[26] In contrast, in 1998, total non-business bankruptcy filings hit 1.4 million. Thus, of the roughly 100 million households in America, 1.4 percent filed for bankruptcy, a nearly four-fold increase since *Marquette*.

Credit Limits

Credit limits, while at the heart of this article, are not easily observed, and tests for the presence of binding credit constraints are rarely definitive. For example,

[26] Source: www.census.gov and abiworld.org.

observed credit lines do not tell us how much additional credit lenders may be willing to extend to households. We also observe true limits only for those who are denied further credit, a group that may not represent the majority of borrowers. However, that credit limits do bind for a subset of households is well established (see Jappelli [1989]). I therefore study outcomes under a variety of credit limits. Mean amounts discharged in personal bankruptcy in recent years have remained close to twice annual income, which motivates setting $\underline{A}^l_{s-post} = -2\overline{Y}^l$. With respect to high-income households, the model here assumes that they do not file for bankruptcy, so their credit limits are less important. For simplicity, I set $\underline{A}^h_{s-post} \approx -2\overline{Y}^h$.

To be consistent with the evidence discussed earlier, credit limits in the pre-*Marquette* era will be kept at least as strict as those in the post-*Marquette* era. Mean amounts discharged in bankruptcy were much smaller in the period immediately following *Marquette,* at close to annual income, than in current times. However, as hard data on credit limits is not available, I explore three levels, ranging from one-half of annual income in the benchmark case ($\underline{A}^l_{s-pre} = -0.5\overline{Y}^l$), to three-fourths annual income ($\underline{A}^l_{s-pre} = -0.75\overline{Y}^l$), and lastly to annual income ($\underline{A}^l_{s-pre} = -\overline{Y}^l$). The pre-*Marquette* limit for high-mean income households is also smaller than in the post-*Marquette* era, and is set such that $\underline{A}^h_{s-pre}$ is roughly one-and-a-half times (high) annual mean income. By setting $\underline{A}^l_{s-pre} = -0.5\overline{Y}^l$, the benchmark case considers the most generous increase in credit availability to low-mean income households. The set of fixed parameters is given in Table 1.

Results

The two main results of this article are as follows.

Result 1 *The stigma-related costs of bankruptcy have risen over the post-Marquette period, not fallen, as has often been suggested.*

Result 2 *The post-Marquette expansion in unsecured credit and current bankruptcy law have together actually lowered the welfare of low-mean income households.*

I begin by providing intuition for the first result. It has by all accounts become distinctly easier to borrow following a bankruptcy in the past decade, as seen in the growth of sub-prime lending, i.e., average credit market exclusion times have fallen. Given the fall in credit exclusion, the model may or may not be able to capture observed filing rates. Subsequently, I relax this assumption and compare welfare under states in a setting that allows for time-varying levels of these difficult-to-observe costs. When λ^l is reestimated in the post-*Marquette* period, it will be set to reproduce observed filing rates, given

Table 1 Fixed Parameters

Parameter	Value	Source
β	0.96	Aiyagari (1994)
α	2.00	
p^i_{gg}	0.74	Heaton and Lucas (1997)
p^i_{bb}	0.74	
Y^h_g	1.76	Kydland (1984); Aiyagari (1994)
Y^h_b	1.44	
Y^l_g	1.32	
Y^l_b	0.68	
$\overline{Y}^h/\overline{Y}^l$	1.60	
$\underline{A}^l_{s-post}$	$-2\overline{Y}^l$	Huggett (1993); Sullivan et al.
$\underline{A}^h_{s-post}$	$-2\overline{Y}^h$	(1989); Culhane and White (1999)
ω	0.386	Autor, Katz, and Kreuger (1998)
r^d	0.035	

the post-*Marquette* term of exclusion from credit markets. This reestimation will allow for the possibility that stigma effects may have changed in recent years, as recent work by Gross and Souleles (1998) suggests. In particular, the assertion that stigma has fallen over time can and will be directly tested by the reestimation of λ^l in the post-*Marquette* era. It turns out that even under the assumption that credit market exclusion continues for ten years, the estimated nonpecuniary cost for the pre-*Marquette* period implies substantially higher bankruptcy rates than have been observed. This result is displayed in Table 2 and is obtained by recomputing the implied penalties, beyond credit market exclusion, that are required to generate the observed filing rate in the post-*Marquette* period. I find that these penalties, when estimated in the pre-*Marquette* era and applied to the post-*Marquette* era, produce far too many filings given the current availability of unsecured credit.

The preceding is a surprising implication of the model, and it suggests that stigma effects haven't fallen in the manner often suggested. For an example of such a suggestion, see Senator Charles Grassley, who states in a May 17, 1997, PBS interview, "There is no shame anymore with bankruptcy" (in "Going for Broke," *A News Hour with Jim Lehrer transcript*, May 17, 1999). For a contrasting view, note the remarks of U.S. Bankruptcy Judge Joe Lee, who states, "I don't see many people cavalier about bankruptcy. The reason for so many bankruptcies is because consumer credit is so overwhelming" ("No More Stigma in Being Broke?" July 25, 2001, *Cincinnati Enquirer*). Anecdotal evidence suggesting that credit market exclusion may not be that

severe can be seen in the explosion of "no credit, bad credit, . . . no problem" advertising populating late-night television.

To understand the second result, I now turn to the results of a quantitative exercise. The benchmark case evaluates the effects of increasing unsecured credit availability when the pre-*Marquette* credit limit for low-mean income agents is set at $\underline{A}^{l}_{s-pre} = -0.5$. The results are presented in Table 2. In the first column of Table 2, I report outcomes for bankruptcy rates, interest rates, consumption, and asset volatility for the pre-*Marquette* era. In the second column, I present the outcomes obtained from the post-*Marquette* environment, when the nonpecuniary costs of bankruptcy are held at their calibrated value from the pre-*Marquette* era. The third column also presents the results after the move to a post-*Marquette* environment; however, in this case the nonpecuniary costs are recalibrated such that the model matches the post-*Marquette* bankruptcy rate of 1.4 percent.[27]

I find that the interest rate on unsecured loans is 9.0 percent, close to its true value in 1980 (see Evans and Schmalensee [1999], p. 239). The coefficient of variation in consumption, denoted $cv(c_l)$ and $cv(c_h)$ for low- and high-mean income households respectively, is roughly one-third that of income for both high- and low-income households. The relatively low ratio of consumption-to-income volatility suggests that even with low bankruptcy rates, households do a good job of smoothing their consumption using asset markets, such as savings accounts and credit cards.

Turning to specifics, note first that as we move from the pre-*Marquette* era to the present, holding λ fixed, bankruptcy rates skyrocket, along with interest rates on unsecured loans. The bankruptcy rate reaches a counterfactually high level of 4.8 percent. The interest rate on unsecured loans is 18.6 percent, also higher than the observed rate of approximately 12.5 percent. The volatility of consumption rises for two reasons. First, as the loan rate rises, borrowing becomes less useful in smoothing. Second, and perhaps more important, is the discrete jump upward of consumption in the periods following a bankruptcy. That is, bankruptcy is an immediate discharge of debts, and thus net wealth rises sharply when a household files for bankruptcy, thereby inducing a concurrent rise in consumption.

The immediate impact on welfare is large. Under a welfare criterion where only low-mean income households matter, denoted ϕ_{low}, the welfare of the poor agent is reduced by an amount equivalent to taking away 3.51 percent of the household's consumption at all dates, regardless of income. Alternatively, the median household would experience a loss equal to an income reduction

[27] Note that I model high-income households as having seen their access to unsecured credit grow. However, given the reliance of this group on secured debt, and the low incidence of bankruptcy in this group, it is not important that its ability to borrow in the unsecured market change across the pre– and post-*Marquette* eras.

Table 2 Results

	pre-*Marquette*	post-*Marquette*	
		λ^l_{fixed}	$\lambda^l_{endog.}$
ρ	10.00	4.00	4.00
λ^i	0.60	0.60	1.48
$\underline{A}^l_s$	$-0.5\overline{Y}^l$	$-2\overline{Y}^l$	$-2\overline{Y}^l$
$\underline{A}^h_s$	$-1.5\overline{Y}^h$	$-2\overline{Y}^h$	$-2\overline{Y}^h$
Π	0.40%	4.80%	1.40%
r^l	9.00%	18.60%	11.60%
r^d	3.50%	3.50%	3.50%
$cv(c_l)$	0.125	0.212	0.118
$cv(c_h)$	0.051	0.051	0.051
ϕ_{low}	n.a.	−3.51%	−2.83%
ϕ_{equal}	n.a.	−2.52%	−2.02%

of roughly $900. When the welfare criterion weights all households equally, welfare losses still fall, but by less, as seen in the row headed by ϕ_{equal}.

Consumption is much less smooth than before, and interest rates are far higher than the 9.0 percent level of the pre-*Marquette* era. Additionally, each of the large number of filings induces the imposition of nonpecuniary penalties, which, ex-post, imply substantial deadweight loss for society. When nonpecuniary costs are recalibrated, however, these welfare losses shrink somewhat, to −2.83 percent when the welfare of only low-mean income households is taken into account. Thus, although the recalibrated cost λ^l_{endog} is larger, at 1.48 relative to 0.60, the reduction in bankruptcy rates from 4.8 percent to 1.4 percent reduces deadweight loss substantially. In turn, interest rates on loans fall, from 18.6 percent under the pre-*Marquette* nonpecuniary cost of 0.60 to 11.6 percent. The consumption of high-mean income agents is much smoother in all cases, at 0.051.

Thus, with respect to the question of whether households are better off with the increased credit available today, even if it has brought with it more bankruptcy, the answer is "no." This result obtains even though three strong assumptions were made in an attempt to enhance the role of easily available unsecured credit and easy bankruptcy. Even when lenders are forced to price loans according to average behavior in the population as a whole, when only low-mean income households file for bankruptcy, I find that bankruptcy lowers welfare. Furthermore, this result holds even when all welfare weight is placed

on the poor. The first reason for the fall in welfare is that households appear to smooth consumption fairly well without bankruptcy, so forcing them to buy the option to file is wasteful. Secondly, easy bankruptcy implies frequent use of deadweight penalties such as credit market exclusion and stigma. Such penalties reduce welfare when imposed after the fact. A third reason is that interest rates on loans rise dramatically, and when credit limits are increased, each bankruptcy discharges more debt than before. Therefore, similar bankruptcy rates may imply a substantially higher interest rate on loans.

The results above are quite robust to credit limits for the poor in the pre-*Marquette* period. As credit limits are relaxed, consumption becomes only slightly smoother, suggesting that even small amounts of credit are sufficient for patient consumers to effectively smooth temporary shocks. For conciseness, these results are not presented in detail here.

Stigma, Individual Debts, and Welfare

Interestingly, because it is hard to argue that credit limits are stricter now than in the pre-*Marquette* era, and equally hard to argue that exclusion from credit markets is greater now than before, we arrive at a somewhat contrarian position. The United States is far from being a country where stigma and personal shame have fallen and where everyone is out to exploit the bankruptcy system; instead, I find that *increased* nonpecuniary penalties, unrelated to statutory or creditor-imposed penalties, are necessary in order to explain observed bankruptcy rates. In particular, given the slow growth rate of real income among the unskilled, the rapid income growth of the skilled, and the rapid increase in unsecured credit, it is puzzling why more households, especially high-income ones, did not file over the past two decades. This strongly suggests that rumors of the demise of stigma and conscience are greatly exaggerated.[28]

A final point concerns mapping from individual circumstances at the time of a bankruptcy filing to inferences about the desirability of a bankruptcy system as a whole. In all of the cases considered in this article, households only filed for bankruptcy when they held the maximum allowable debt and were then hit by the low income shock. Despite the fact the only the "desperate" filed for bankruptcy in this model, bankruptcy protection was still found to be a welfare-reducing insurance system. Consider then the debate between Senators Charles Grassley and Paul Wellstone referenced in footnote 2. In their debate, much was made of the attitudes and circumstances of individuals in bankruptcy, as if these considerations immediately made clear the desirability or lack thereof, of bankruptcy. To the extent that the inability to opt out

[28] As noted earlier, this result survives even if the credit market exclusion period is fixed in both eras at ten years.

of bankruptcy protection lowers welfare, seeing people in dire straits at the time of filing may simply suggest that deadweight and nonpecuniary costs of bankruptcy are so large that the institution of bankruptcy may well reduce aggregate welfare.

4. CONCLUSIONS

The results presented here should be interpreted as a first estimate of the welfare consequences of the post-*Marquette* expansion in unsecured credit. The results demonstrate that the interaction of the post-*Marquette* expansion in unsecured credit with current bankruptcy law has led to a decrease in aggregate welfare. That is, expanded unsecured credit, when combined with lax bankruptcy law, helps some poor people at the expense of other poor people in a manner that reduces overall welfare. Strikingly, the results presented here may even understate the welfare costs of bankruptcy.

Perhaps a more subtle point is that in each of the experiments considered here, the households that filed had hit their borrowing constraint. However, while households are almost always in desperate straits at the time of bankruptcy, which might suggest that bankruptcy is being used wisely, this circumstance in no way implies that the system overall is welfare-improving. The penalties for bankruptcy are not definitively connected with the level of debt defaulted on. Therefore, rational households have incentives to carry large debts, although these incentives are balanced here by the possibility of having to service them. That is, the position of households at the time of filing may say precious little about overall desirability of the bankruptcy system. The latter has been a point of confusion in recent public debate.

The model developed here also strongly suggests that U.S. households are actually less inclined to file for bankruptcy, all else equal, than they were in the pre-*Marquette* era. That is, the increase in filing rates is well accounted for by an increase in credit available to low-income households. This result echoes the work of Ellis (1998) and Moss and Johnson (2000).

The results presented here are perhaps a lower bound on the welfare loss from easy unsecured credit and lax bankruptcy. Of the three assumptions used above, Assumption 1, that high-income households do not file for bankruptcy, is particularly important. While the assumption can be rationalized by supposing that high-income agents face large nonpecuniary penalties for filing, it is not statutorily accurate. High-income people can, if anything, file more easily than low-income people. The rich have smoother incomes, making exclusion from credit markets less painful for them. At present, the rich can get more credit, which will allow them to consume more prior to default. Therefore, there is something very intangible keeping bankruptcy rates from being much higher than they are.

In terms of the desirability of returning to a pre-*Marquette* world, the present-day environment is advantageous in that a large efficient payments network exists alongside substantially better credit risk management. The latter allows lending to a group that found borrowing difficult before *Marquette*. The downside of the current environment is that the mean level of consumption volatility is still higher than it would be in a world where individuals could credibly commit to repaying loans. Thus, the real welfare loss comes from a subset of low-income, low-wealth households being prevented by bankruptcy law from credibly committing to repaying loans. Additionally, the inability to impose penalties that transfer resources from borrower to lender necessitates high interest rates on unsecured credit and the frequent use of socially costly bankruptcy penalties. These latter penalties appear to render bankruptcy a fundamentally inefficient system for risk bearing. One possible remedy here is to allow individuals to *pre-commit* to debt rescheduling, rather than to let them be forced into Chapter 7 liquidation.[29] If pre-commitment to debt rescheduling in lieu of outright liquidation were allowed, those who wanted to retain the option to file for a Chapter 7 bankruptcy could be charged a higher price for the option, while others could opt out of Chapter 7 bankruptcy rather than being forced to pay for it as they are now.

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[29] However, see Jackson (1985) for an argument in defense of disallowing pre-commitment.

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Regulating Bank Capital Structure to Control Risk

Edward S. Prescott

The most important recent developments in bank regulation are based on capital requirements. For example, the Basle Accord of 1988 specifies that bank capital must be at least 8 percent of a bank's risk-weighted assets.[1] Also, the Federal Deposit Insurance Corporation Improvement Act of 1991 (FDICIA) requires regulators to shut down a bank whose capital has dropped below a cutoff level.

While these regulations are important, their focus is too narrow in that they concentrate solely on equity. There are other types of financial instruments available, and these can be even more effective than capital requirements at controlling risk. Proposals to require banks to issue subordinated debt recognize this, but even those proposals do not make full use of the possibilities available. This article argues that capital regulation can be improved by using financial instruments like convertible debt and warrants with high strike prices. Furthermore, some of the improvement brought about by these instruments would allow a reduction in the traditional capital requirements.

Any economic study of bank capital regulation requires a theory of capital structure. Modern theories of corporate financial structure start with the celebrated result of Modigliani and Miller (1958): that in a world without taxes or bankruptcy costs, the value of a firm does not depend on its capital structure. These theories then consider departures from the world of Modigliani and Miller—departures that cause the capital structure to matter. The particular departure studied in this article is agency theory. In the agency theory of capital structure, limited liability creates an incentive for highly leveraged firms to take excessive risk. These incentives are made worse in banking because

The author would like to thank Kartik Athreya, Tom Humphrey, David Marshall, Roy Webb, and John Weinberg for helpful comments. The views expressed in this article do not necessarily represent the views of the Federal Reserve Bank of Richmond or the Federal Reserve System.

[1] Recent proposals by the Basle Committee on Banking Supervision are still based on capital requirements even though they change the way the requirements are calculated.

of deposit insurance. This idea was developed by Merton (1977) and Kareken and Wallace (1978) in the context of deposit insurance and is related to the agency theory of capital structure developed by Jensen and Meckling (1976).[2]

The analysis presented in this article is a simplified exposition of the analysis contained in Marshall and Prescott (2001). They examine the value of augmenting capital regulations with securities that fine-tune the payoff received by a bank. In the Marshall and Prescott model, a bank chooses the risk and mean characteristics of its loan portfolio. For reasons described later, limited liability and government insured bank debt gives banks an incentive to take risk. They find that capital requirements are much more effective at controlling risk taking if they are augmented with securities like warrants or convertible debt. As in Green (1984), these latter instruments control risk taking because they lower the net return to a bank when it performs extremely well.

The present article's focus on controlling risk taking is particularly relevant to banking. The most striking example of a failure to control risk-taking incentives is the savings and loan crisis of the 1980s. The standard story told about this event is that the inflation of the 1970s lowered the value of the savings and loans' fixed rate mortgages to the point that many had a negative net worth. Because of this negative net worth, the savings and loans had nothing to lose by taking on lots of risk. The deregulation of the early 1980s gave the savings and loans the opportunity to take on the risk, and many failures throughout the 1980s resulted.[3]

There is additional evidence of excessive risk taking. Boyd and Gertler (1994) argue that large banks, who had stronger deposit insurance protection due to the "too big to fail" doctrine, took more risk than smaller banks during the late 1980s, which was a period of widespread banking problems. Other studies have found a connection between low capital levels and bank risk. The survey in Berger, Herring, and Szego (1995) lists studies that imply that a higher capital ratio is associated with lower bank risk, though this relationship is sometimes weak. On a related point, several researchers have found that franchise value is negatively correlated with risk. Franchise value is the value of continued operations by the bank and can represent organizational capital or the present value of future lending opportunities. Failure of the bank would mean a loss of its franchise value, which implies that high-franchise-value

[2] For a survey on non-tax-driven theories of capital structure, see Harris and Raviv (1992).

[3] Another important part of this story is why so few banks failed from World War II until the early 1980s. Keeley (1990) argues that in this period, banking was heavily regulated with numerous protections that reduced competition. These protections included restricted entry by limiting charters and branching, and limited price competition by interest rates controls. Because of these protections, banks received a flow of monopoly profits that would be lost if the bank went bankrupt. For this reason, banks behaved prudently.

banks would behave more prudently than low-franchise-value banks. Evidence that in the 1990s U.S. banks with low franchise value took more risk than those with high franchise value is contained in Demsetz, Saidenberg, and Strahan (1996). In an international sample of banks, De Nicolo (2000) finds that franchise value decreases and risk increases with bank size.

1. THE PURE DEBT AND EQUITY CASE

This section analyzes bank capital regulation when a bank is restricted to issuing only debt and equity. This simple environment is useful for reviewing corporate finance theory and for discussing bank regulation. It will also be valuable in assessing the gain from introducing instruments like warrants into bank capital regulation, as is done in Section 2.

A bank's financing problem is considered under three different sets of assumptions. The first set illustrates the Modigliani-Miller Theorem. The second set of assumptions is based on the agency cost theory of Jensen and Meckling (1976). The present article, however, restricts its focus to the agency cost of debt; agency costs of equity are ignored because the focus on debt costs is all that is needed to illustrate the risk-control properties of warrants and convertible debt.[4] The final set of assumptions adds deposit insurance to the agency cost story; this set illustrates how deposit insurance creates additional risk-taking incentives and how it shuts down the market's incentive to control the bank's risk taking. Recent subordinated debt proposals are discussed.

Consider a bank with an investment project that requires exactly one dollar of investment. The risk-neutral owner or manager of the bank also has one dollar of funds that he or she can either invest outside the bank at the risk-free rate of zero or hold as equity in the bank.[5] Any investment not funded by equity must be funded by debt that is raised from the market. For the purposes of this article, the terms *debt* and *deposits* will be used interchangeably. Because of limited liability, debtholders cannot be repaid out of the returns to the banker's market investments. Instead, if the face value of the debt cannot be repaid out of the bank's investment project, then the bank is liquidated and whatever is left is used to pay the debtholders. Finally, since the exogenous risk-free rate is zero, debtors must receive an expected gross return of 1.0 on their debt.

After raising the investment funds, the bank chooses one of two investment strategies. It can choose a high-mean, low-risk strategy or a low-mean, high-risk one. The high-mean strategy has a one-half probability of paying 0.5

[4] Marshall and Prescott (2001) contains additional features that generate an agency cost for equity.

[5] The treatment of equity owners and managers as the same entity is common in the corporate finance literature. This assumption, however, is not without consequences. Even so, the analysis in this article should still apply to managerial pay.

and a one-half probability of paying 1.5. In expectation this strategy pays 1.0, which is the risk-free gross return. The low-mean strategy has a one-half probability of paying 0.25 and a one-half probability of paying 1.6. It pays 0.925 in expectation. The high-mean strategy is the socially desirable option.[6]

The Modigliani-Miller Theorem

For the first set of assumptions, the bank can commit to the investment strategy that it will take. Let D be the amount of debt raised and let F be the face value of the debt, or the amount the bank repays if it has the available funds. Also, let I be the amount of funds invested in the market by the banker. Of course, for each dollar of own funds invested in the market, the banker has to raise one dollar in debt; therefore, $D = I$ in this environment.

If the bank commits to the safe, high-mean investment strategy, then for debt $D \leq 0.5$ the bank always has enough funds to pay back debtholders. In this case, $F = D$ and the banker's expected payoff is

$$0.5(0.5 - D) + 0.5(1.5 - D) + I = 1. \tag{1}$$

For debt in the range $0.5 < D \leq 1.0$, the bank cannot fully pay back the depositors if it produces the low return. To compensate for this loss, the face value of debt needs to reflect a risk premium. The risk premium depends on the amount of debt issued. In particular, the face value of debt must satisfy $(0.5)(0.5) + (0.5)F = D$, which implies that $F = 2D - 0.5$. Therefore, if the bank's investment project is entirely financed with debt, that is, if $D = 1.0$, then the face value of the debt would be 1.5. If the bank fails the debtholders receive 0.5, and if it succeeds they receive 1.5, which in expectation is 1.0, the risk-free rate.

For $0.5 < D \leq 1.0$, the bank's expected payoff is

$$0.5(0.0) + 0.5(1.5 - 2D + 0.5) + I = 1, \tag{2}$$

which is the same level as if it issued debt such that it never defaulted.

Similar calculations for the risky investment strategy reveal that the bank's expected payoff of committing to that strategy is also independent of the debt and equity structure, though the bank's expected payoff is at the lower value of 0.925. The value of the firm depends only on its investment decision, and its capital structure has no effect on its investment decision. This invariance of the value of the firm to its financing decision is an example of the Modigliani-Miller theorem (Modigliani and Miller 1958).

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[6] Implicit in the analysis is the assumption that the bank must make an investment decision; that is, it cannot simply invest its funds in the market and not operate. This assumption prevents the trivial regulatory solution of shutting the bank down, and it is only necessary because the bank's return under the high-mean strategy is the same as that of the market and this is a linear partial equilibrium model. In a general equilibrium model with some diminishing returns, the expected returns would be equal in equilibrium and the banking sector would still operate.

Jensen and Meckling

For the second set of assumptions, I assume that a bank's investment decision is private information, that is, known only to the bank. Jensen and Meckling (1976) use this assumption to establish a connection between the investment and financing decisions of a bank.[7] Under private information, a bank cannot commit to its investment strategy. Instead, given its capital structure, an investment strategy must be in the best interest of the bank, that is, incentive compatible. Of course, the market anticipates the bank's inability to commit and the price of debt will reflect whichever strategy the bank is expected to choose given its debt structure.

There are three distinct ranges of debt to analyze. If $D \leq 0.25$, then the bank can always honor its obligations no matter which investment strategy it chooses. For this case, the analysis is the same as that in the Modigliani-Miller case. The face value of debt is $F = D$. The bank owner receives a payoff of 1.0 by taking the high-mean strategy and 0.925 by taking the low-mean strategy, so he or she takes the safe strategy.

For the second debt range, of $0.25 < D \leq 0.5$, there is no failure if the bank takes the safe, high-mean strategy. In this case $F = D$ and the bank's return is 1.0 as before; however, because of the private information assumption, it must now be verified that this strategy is incentive compatible. We therefore need to calculate the bank's expected payoff from issuing this debt contract and taking the low-mean, risky investment strategy. If this number is less than or equal to 1.0, then the safe strategy is incentive compatible; if it is greater than 1.0, then it is not. In this case, the market will recognize that under this debt structure the bank takes the risky strategy and it will price the debt accordingly.

When the market thinks the bank is taking the safe strategy but it is really taking the risky strategy, the bank's return is

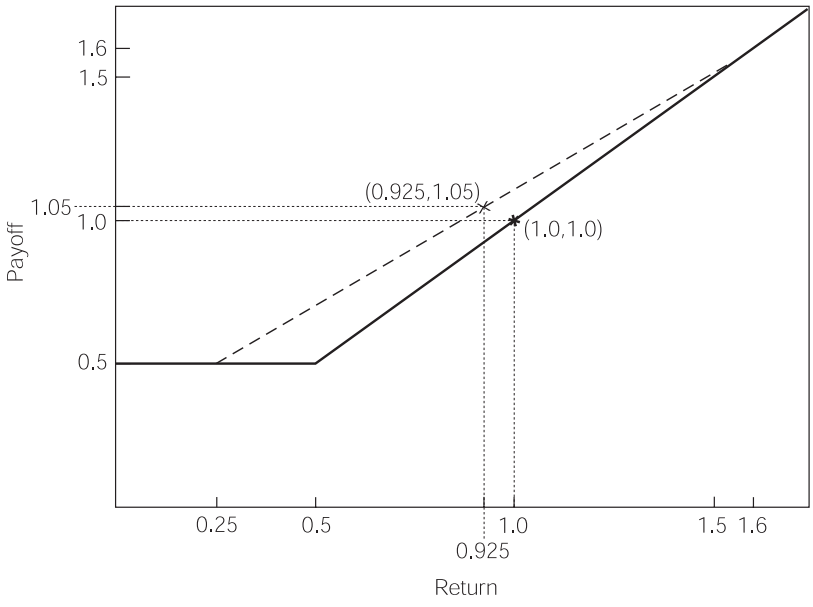
$$0.5(0) + 0.5(1.6 - F) + I = 0.8 - 0.5F + I = 0.8 + 0.5D. \qquad (3)$$

For $D \leq 0.4$, the value of equation (3) is less than or equal to 1.0 (what the bank receives from taking the safe strategy), so the safe strategy is incentive compatible. Above 0.4, however, the value of equation (3) is greater than 1.0, so at these debt levels the safe strategy is not incentive compatible.

Figure 1 illustrates the risk-taking incentives created by limited liability. The solid line is the bank's payoff as a function of the return given that the bank has raised $D = 0.50$ and that the market assumes that the bank is taking the safe strategy, that is, $F = D$. The payoff function is piecewise linear and convex because of limited liability. This convex shape generates a taste for risk on the part of the bank. If the bank takes the safe strategy, its payoffs range

[7] Jensen and Meckling's (1976) analysis applies to all firms, not just to banks.

Figure 1 Risk-Taking Incentives Created by High Levels of Debt



The solid line is the bank's payoff as a function of the return given that $D = 0.5$. It is horizontal over the range 0.0 to 0.5 because of limited liability. Above 0.5, the slope of the line is 1.0 because once the debt is repaid all returns above 0.5 accrue to the bank. The dashed line connects the two possible returns (0.25 and 1.6) if the risky investment is taken. The first coordinate of x (0.925) is the expected return if the risky strategy is taken. The second coordinate of x (1.05) is the bank's expected payoff. The first and second coordinates of * are the corresponding values if the bank takes the safe strategy.

over a linear portion of the returns (over 0.5 and 1.5) and the bank's expected payoff is 1.0, just like that of the investment project. In contrast, if the bank takes the risky strategy, it gains from the convexity. Consider the dashed line in Figure 1, which connects the payoff from the two returns produced by the risky strategy (0.25 and 1.6). Because of limited liability, a return of 0.25 gives the bank a payoff of 0.5 (the return on its market investment). The convex payoff function rewards a bank on the upside without punishing it on the downside, and this payoff structure is reflected in its higher expected payoff of 1.05, despite producing a socially inefficient investment return of only 0.925, as indicated by the x in Figure 1.

Of course, for $0.4 < D \leq 0.5$, the market realizes that the safe strategy is not incentive compatible, and it prices the bank's debt as if it has taken the risky strategy. Thus, if the bank takes the risky strategy, the face value of the debt is $F = 2D - 0.25$ and the bank's expected payoff is 0.925.

The final range of debt levels is $D > 0.5$. For this range, there is a chance of default even if the safe strategy is taken. This changes the formula for the face value of the debt, but the high-mean strategy is still not incentive compatible for the same reasons described earlier in relation to the second range of debt levels. Consequently, the bank will choose the risky strategy so the face value of debt is $F = 2D - 0.25$ and the bank's expected payoff is 0.925.

Market Responses

Given these expected payoffs, the bank will choose a capital structure with $D \leq 0.4$ and then take the safe, high-mean strategy. The value of the firm is 1.0, the expected payoff of the safe, high-mean strategy. For higher levels of debt, the market realizes that the bank cannot commit to the safe strategy. Consequently, it prices the debt as if it were taking the risky strategy. The value of the bank for these debt levels is 0.925, the expected payoff of the risky, low-mean strategy. In the world of Jensen and Meckling (1976), the value of a firm is not invariant to its capital structure.

Debt prices are not the only area in which a market may respond to capital structure. For example, debt contracts often include covenants that restrict borrower activities or trigger call options. The market also may decide to spend resources monitoring the borrower. All of these activities can be viewed as costly methods for reducing the adverse effects of private information. In the present article, with no costs to equity these unmodeled additional features are not needed, but in more general environments they very well may be. I will return to this issue below in the discussion of bank regulation.

Deposit Insurance

The final set of assumptions I consider is the addition of deposit insurance to the agency theory of Jensen and Meckling (1976). In practice, deposits (up to a limit) are the only debt explicitly insured. But bailouts may implicitly insure other types of bank debt. To keep the analysis simple, I assume that all bank debt is insured in one way or another. Insurance in this context means that if the bank does not have enough funds to pay back debtholders, the government insurer will make them whole. More specifically, insurance means that debtholders always receive a payment of D, so the face value of the debt is $F = D$. I also assume that the government provides deposit insurance for free. This assumption is a reasonable approximation of present FDIC policies. My analysis in this section is quite similar to that done under the second set of assumptions, which had no deposit insurance, but now the government insurance also leads to transfers to the bank via underpriced debt.

For $D \leq 0.25$ the bank can always pay back debtholders, so there is no incentive problem and the analysis is the same as under the first two sets of assumptions. The bank's expected payoff is 1.0 if it takes the safe strategy and 0.925 if it takes the risky strategy. Consequently, it will choose the safe strategy.

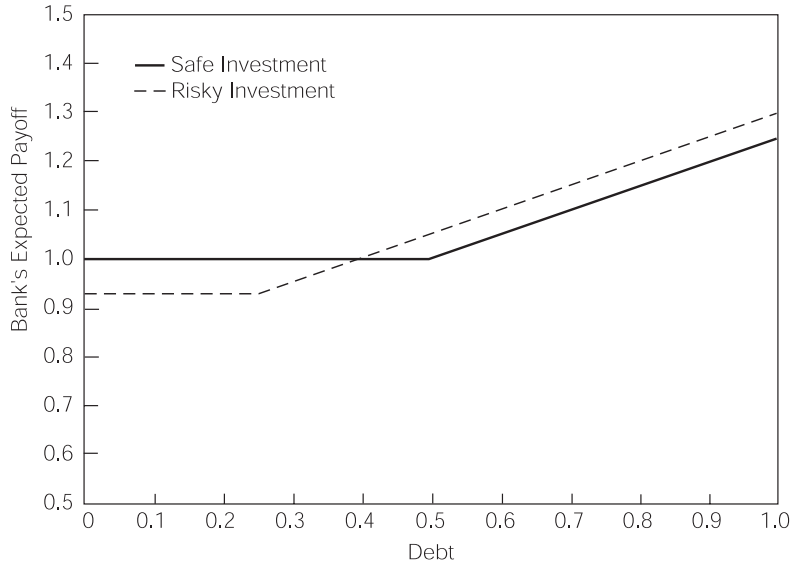
For $0.25 < D \leq 0.5$ most of the analysis is the same as that under the previous set of assumptions. At or below 0.4, the safe investment is incentive compatible and since $F < 0.5$, there is no default; that is, $F = D$. For $D > 0.4$, the safe investment is no longer incentive compatible, so the bank takes the risky investment, just as it did without deposit insurance. What changes, however, is the face value of the debt and the bank's expected payoff. Deposit insurance always makes debtors whole, so there is no longer a need for a risk premium. Consequently, $F = D$ and the bank's expected payoff increases because it has to pay out less when it does well. For $D > 0.4$, the bank's expected payoff is

$$0.5(0.0) + 0.5(1.6 - F) + I = 0.8 + 0.5D. \tag{4}$$

Figure 2 describes the bank's expected payoff as a function of its investment strategy and debt level. The higher expected payoff level indicates which investment strategy is incentive compatible at a particular level of debt. For debt levels below 0.4, the bank chooses the safe investment, but for debt levels above 0.4, it chooses the risky investment. The bank's choice of investment strategies is identical to the previous case without deposit insurance. However, as can be seen in Figure 2, the bank's expected payoff exceeds 1.0 for debt levels exceeding 0.4 and it increases with leverage. The value of the bank increases with leverage because expected transfers from the government increase. These expected transfers are considered by the market as part of the return generated by investment in the bank's debt. These additional transfers are sometimes referred to as the value of the deposit insurance put option (Merton 1977). A put option is the right to sell something at a fixed price. In this case, the bank has the right to sell its losses at a strike price of zero to the deposit insurance fund. Because the bank is able to dump its losses on the insurance fund, the value of its investments increases and, in this example, this increase accrues entirely to the banker.

In contrast with the second set of assumptions, risk is *not* reflected in the face value of bank debt, which shuts down the market's desire to control risk. The problem is so severe in this example (i.e., with deposit insurance) that without any restriction on its capital structure, the bank would choose $D = 1$ and the risky investment strategy. In this example, the loss in output is the only social cost from deposit insurance. There are, however, additional unmodeled costs of deposit insurance. For example, deposit insurance payments could require some potentially distorting taxes, while the high returns would encourage too much entry into banking.

Figure 2 Bank's Expected Payoff as a Function of Debt under Deposit Insurance



The solid line lists the bank's expected payoff as a function of the debt level and given that it takes the safe investment strategy. The dashed line corresponds to the risky investment strategy. Both lines are horizontal over lower levels of debt. In these ranges there is no default and the bank's expected payoff depends only on the return to its investment. This is not true at higher levels of debt because of deposit insurance. The price of debt does not reflect the true risk of the bank's investment. Instead, debt is priced as if it is risk free because the deposit insurer makes debtors whole by transferring resources to them in the case of failure. These expected transfers increase with the size of the debt. Furthermore, from the perspective of the bank and its investors, these transfers are simply additional returns generated by the bank's investment strategy. Consequently, the bank's expected payoff increases in leverage.

Bank Regulation

Without deposit insurance, the market prices debt to accurately reflect risk and monitors or imposes debt covenants to control risk. These measures align the bank's interests with those of society. With deposit insurance, however, the market has no reason to properly price the risk, to impose limitations on bank capital structure, or to place restrictive covenants in debt contracts, so the bank's interests are not aligned with society's.

Much of safety and soundness regulation can be viewed as an attempt by the government to replicate what the market would do in the absence of government deposit insurance. Capital requirements are the most striking

example of this. In the numerical example, a capital requirement of 60 percent would eliminate any risk-taking incentives and generate the social optimum. It would also prevent banks from maximizing their leverage in order to exploit the deposit insurance put option. FDICIA seems to acknowledge the dangers of high leverage when it allows regulators to shut down or limit the activities of undercapitalized banks.

The parallels between market measures and governmental regulations extend to other regulations as well. For example, the activities in which banks may engage are limited. There are prohibitions on the amount of lending a bank can do to a single entity. Examiners audit and assess bank practices.

Recent proposals that require banks to issue subordinated debt can be viewed as an attempt to return some of the monitoring role to markets. Unfortunately, much of the discussion about the merits of these proposals focuses on the signal about risk revealed by prices, as in the example. But as was discussed in the section about market responses, debtholders not only price risk but may require covenants or changes such as increased transparency of investment. For an excellent discussion of the parallels between market measures and bank regulation, see Black, Miller, and Posner (1978).

2. MORE GENERAL CAPITAL STRUCTURES

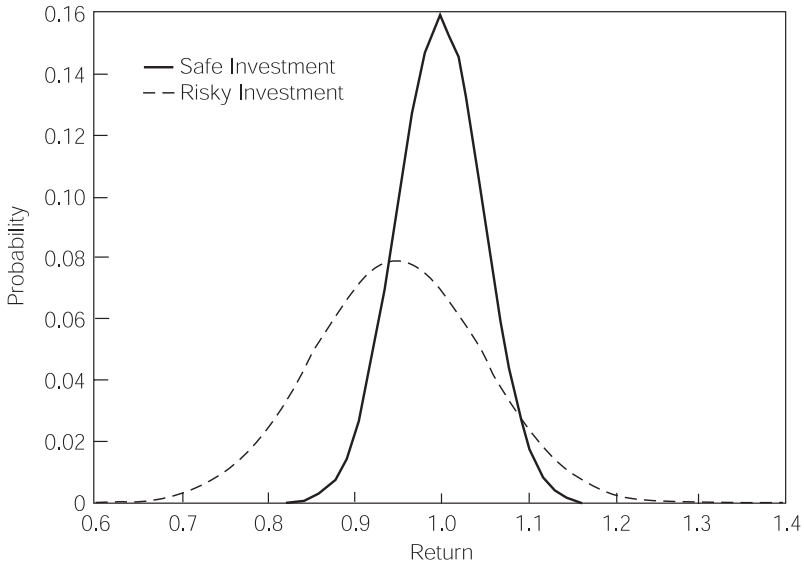
The analysis in Section 1 limited the available financial instruments to debt and equity (the latter is really the banker's own funds). This limitation illustrated the corporate finance principles at work and demonstrated how capital requirements can work. For some purposes, restricting the analysis to debt and equity is not limiting. For example, in a Modigliani and Miller world, the invariance of firm value to capital structure still holds for more general capital structures. In the Jensen and Meckling world, however, additional financial instruments can be quite effective at controlling risk, and by extension, these same financial instruments can be effective regulatory tools.

Section 2 builds on the previous analysis by adding a richer return structure, which brings us a step closer to the full model in Marshall and Prescott (2001). The new example is first studied in the case in which the bank regulatory capital requirements can only take the form of minimum equity requirements, as under present regulations. Next, the example is studied in the case in which capital requirements can restrict the entire capital structure; that is, regulations can require issue of securities other than debt and equity. As will be shown, much more debt can be issued in the latter case.

As before, there is deposit insurance and the bank can choose a high-mean, safe investment strategy or a low-mean, risky one.[8] Now, however, a multitude

[8] The example posits a reverse mean-variance tradeoff in investment returns. Marshall and Prescott (2001) study a more general set of possible investment strategies where the bank chooses

Figure 3 Probability Distribution of Returns



The two lines list the probability distribution of returns for each investment strategy. Both distributions are approximately normal, though truncated from above and below. The safe investment strategy has a mean of 1.0 and a low variance. The risky investment strategy has a mean of 0.95 and a higher variance. If the risky strategy is taken, the return is much more likely to be very low or high than if the safe strategy is taken.

of returns can be generated. Figure 3 shows the probability distribution of the returns for each investment strategy. The solid line is the return for the risky strategy and the dashed line is the return for the safe strategy. The mean of the risky strategy is 0.95 while the mean of the safe strategy is 1.0. Both distributions are approximately normal but with differing means and variances.[9]

The other difference from the previous section is that the bank is allowed to lower its return without cost if it so desires. This assumption is reasonable

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both the mean and variance of its investment strategy. In that setup, the incentive constraint that matters the most is the one where the agent deviates to the high-risk, low-mean strategy. The formulation adopted herein is designed to capture this feature.

[9] The distributions were generated in the following way. The set of returns was divided into an equally spaced grid of 21 points over the range 0.6 to 1.4. The risky investment strategy probability distribution was created by evaluating each return with a normal distribution of mean 0.95 and standard deviation 0.3. These numbers were then normalized to sum to one in order to generate a probability distribution. The safe investment strategy was created in the same way except that the mean is 1.0 and the standard deviation is 0.2.

because it is easy enough to raise costs in order to lower profits. It is also appealing to make the assumption because it guarantees that the net payoff to the bank is monotonically increasing in its return, otherwise, the bank would destroy returns to a point where its net return was highest.[10]

For each case, we find the regulatory policy that is best from society's perspective. Because the example leaves out any costs of equity finance, an all equity financed firm would face no incentive problem and would receive no transfers in expectation from the deposit insurer. To avoid this result, I use as society's criterion the maximum amount of debt the bank could raise while keeping the high-mean, safe investment strategy incentive compatible. This social objective function is sufficient for the purpose of illustrating the risk-control features of warrants and subordinated debt. Marshall and Prescott (2001) contains additional features such as liquidity services from bank deposits and franchise value that lead to additional factors in determining optimal capital regulation.

The most debt that can be supported in the minimal equity requirement case is $D = 0.94$ with equity equal to 0.06. The bank provides 0.06 of its own funds to satisfy the capital requirement and raises the rest in deposits. This quantity is the most highly leveraged capital structure that the bank can have while still providing an incentive for it to take the safe, high-mean investment. The expected payoff of the bank is 1.0466, which is greater than 1.0 because in expectation some transfers are made to the bank from the deposit insurance fund when the bank fails. Under the assumptions in this example, these extra funds accrue to the bank's owner as additional expected profits.

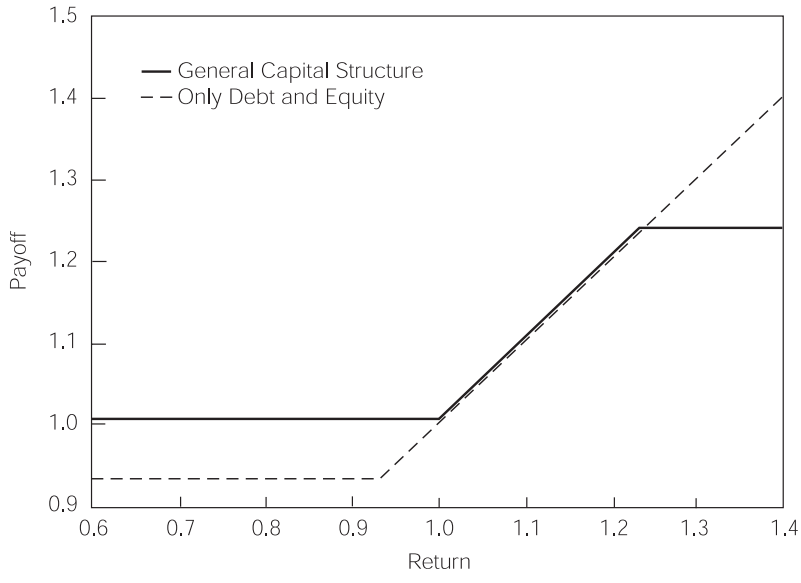
Under more general capital requirements, much more debt can be supported while keeping the high-mean strategy incentive compatible. The solution to the general capital structure problem contains much more debt. In this example, the bank can fund its investment entirely with debt, that is, $D = 1.0$. The bank's expected payoff is 1.0729, reflecting the increased transfers from the government.[11] Despite the high leverage, the safe investment is incentive compatible because of the way payoffs to the bank are structured.

Figure 4 reports the payoff to the bank as a function of the return for both the minimal equity requirement problem and the general capital regulation problem. The dashed line lists the payoff for the pure debt and equity case. It is horizontal at a level of 0.94 from 0.6 to 0.94. For this range of returns, the bank's entire payoff comes from its own funds that it invested with the market at the risk-free rate. Everything produced by the investment project goes to debtholders. Above 0.94, the investment project begins to pay off for

[10] This assumption has no effect on the pure debt and equity case because equity is intrinsically monotonically increasing.

[11] Since there is nothing that resembles equity when $D = 1.0$, the return to the bank should be viewed as payments to the banker for supplying investment services.

Figure 4 Bank's Payoff as a Function of the Return



The dashed line lists the payoff to the bank if a minimal equity requirement of 0.06 is imposed on it. For returns above 0.94, the bank's payoff increases because it has paid off its debt and keeps the remainder. The solid line lists the payoffs to the bank generated by the best set of general capital requirements that can be imposed. Under these capital requirements, the bank issues 1.0 units of debt but cannot keep returns in excess of 1.26. These returns must be paid to outside investors. By limiting the payoff from high returns, this payoff structure makes the high-variance investment strategy unappealing.

the bank. All additional returns accrue to the equity holders (the banker) so their payoff is linear in the return with a slope of one. This payoff structure is convex, but the 6 percent capital requirement is enough to prevent the bank from taking the risky investment. However, if the bank issued more debt the payoff structure would shift to the right, making the payoff structure even more convex and making the safe strategy no longer incentive compatible.

The solid line lists the payoff structure to the bank that general capital regulations should try to duplicate. At this point, I only discuss the payoffs, but later I describe how specific financial instruments can be used to generate this payoff structure. Over the range of 0.6 to 1.26, the payoff for the general capital structure case has a similar shape to that of the pure debt and equity case. Above this range, however, the bank's payoff is horizontal in the return. This feature reduces the range of returns over which the bank's payoff is convex, which helps to control risk taking. Furthermore, an examination of

Figure 3 reveals that low and high returns are much more likely under the risky strategy than under the safe strategy. The ratio of the probability of a given return under the risky strategy to the probability of that return under the safe strategy is called the *likelihood ratio* for that return.[12] The goal of the capital structure is to keep payoffs to the bank low when the ratio is high, and to keep it high when the ratio is low. This payoff structure rewards the safe strategy relatively more than it rewards the risky strategy if the bank indeed followed that strategy.

The role of likelihood ratios can be seen more formally. For simplicity, assume there is a finite number of returns. Let $p_s(R)$ be the probability of return R if the safe investment strategy is chosen, and let $p_r(R)$ be the corresponding probability if the risky investment is chosen. Also, let $u(R)$ be what the bank receives, net of payments to all security holders. The incentive constraint is

$$\sum_R p_s(R)u(R) \geq \sum_R p_r(R)u(R).$$

This constraint says that the expected payoff the bank receives from the safe strategy must be at least as much as it would receive if it took the risky strategy. If $p_s(R)$ is low and $p_r(R)$ is high, then it is desirable to set a low $u(R)$. Conversely, if $p_s(R)$ is high and $p_r(R)$ is low, then it is desirable to set a high $u(R)$.

In this example, the likelihood ratio is at its highest level for low returns. The regulator would like to prevent the bank from taking the risky investment by lowering the bank's payoff for these returns as much as possible. Because of limited liability, however, these payoffs cannot be lowered below zero. (Recall that the bank still receives payments from its risk-free investment. This accounts for its positive payoff.) At high returns, this ratio is also high, but limited liability does not bind so payoffs to the bank are lowered. Interestingly, it would be desirable to lower payoffs in these returns to zero, but because of the monotonicity requirement (from the costless destruction of returns assumption) there are limits to which these returns can be lowered.[13]

A Capital Structure That Replicates the Payoffs

Figure 4 describes the optimal payoff structure. But can this structure be replicated with a combination of financial instruments that regulators can require banks to hold? The answer is yes. One way to do this is for the bank to issue warrants with a strike price of 1.26. A warrant is an option that gives the

[12] See Hart and Holmstrom (1987) for more analysis of likelihood ratios in moral hazard models.

[13] For more details see Marshall and Prescott (2001), who compare solutions with and without the monotonicity constraint.

owner the right to buy shares at the strike price. If the bank produces a return of more than 1.26, a warrant holder collects the difference between the return and the strike price by exercising his or her warrant, and the bank receives just 1.26. This accounts for the flat payoff to the bank for returns above 1.26. But, more generally, if the exercised warrants make up only a fraction of the equity, then the bank's payoffs for returns above 1.26 will increase (though at a slope less than one).

Selling a warrant is equivalent to selling a portion of the bank's return above the strike price; the exact portion depends on the relative share of warrants and existing equity. In this example, selling the warrant is valuable because it allows the bank to be more highly leveraged than in the pure equity case, while keeping the safe, high-mean strategy incentive compatible. Furthermore, because the bank can finance its entire investment with debt, the income received from selling the warrants is reinvested at the market rate along with the banker's own 1.0 units of funds. For this reason, the bank's payoff slightly exceeds 1.0 for the range of returns between 0.6 and 1.0.

The analysis contains a clear message about capital regulation. Capital requirements that control risk by lowering the upper-tail payoff to banks can improve upon the existing capital regulations. Warrants with a high strike price are not the only financial instruments that can do this. For example, convertible debt is debt that can be converted into equity at some agreed-upon price. For a high enough strike price, convertible debt could substitute for warrants. Alternatively, equity swaps might be possible.

Some Caveats

In assessing different financial instruments, it may be important to consider additional features of financial instruments like control features or ability to trade. If the banker sold warrants at a strike price of 1.26, he or she would be turning the bank over to the warrant holders whenever the warrants were exercised. Managers rarely want to give up control. The static analysis in this article is inappropriate for an analysis of control; however, if control was indeed an issue, then other financial instruments like swaps that separate control from cash flow might be valuable.

Another point is that in this analysis, it matters who holds the warrants. In the example, there is an anonymous market that purchases them, but if the banker bought them, it would undo his or her incentives since his or her payoff structure would then look convex again. In practice it would be necessary to ensure that owners of the warrants are not the same people who own the equity of the firm.

3. FINAL COMMENTS

This article argues that financial instruments, such as warrants or convertible debt, should be considered as part of capital regulations. They are effective at controlling risk-taking incentives because they lower the payoff to a bank that engages in risky activities without adversely affecting a bank engaged in safe activities. Furthermore, at least in the example in Section 2, imposing these requirements would allow a reduction in the traditional capital requirement of an equity minimum.

While the example necessarily leaves things out, the analysis in Marshall and Prescott (2001) includes several additional features and still finds that financial instruments like warrants and convertible debt are potentially valuable regulatory tools. They include franchise value and disutility to managers from screening the quality of its loans. These two features give equity some value in their environment. They also include a utility value of deposits, which is designed to capture the payment and liquidity services that deposits provide but other kinds of debt do not. Furthermore, they allow banks to choose from a richer set of investment strategies. Banks are allowed to choose the variance and by screening, the mean, of its investment portfolio.

They find that the most binding incentive constraint is the one on the bank taking the low-mean, high-variance investment. The regulator sets its capital requirements mainly to prevent the bank from taking this investment strategy. This reverse mean-variance tradeoff is the justification for the simple two distribution choice faced by banks in this article. For low franchise values, they find results qualitatively very similar to those in this article. Equity minimums are higher under standard capital requirements than under a capital requirement that also uses instruments like warrants with a high strike price. For higher franchise values, they find that capital requirements are not that important and that the banks will choose high levels of capital, in order to reduce the chance of bankruptcy.

One important feature that Marshall and Prescott (2001) do not study is that warrants and convertible debt may punish banks whose high returns are generated by innovation or just simply better management. The investment choices in their paper, as well as in this article, do not capture this phenomenon. Future research should be concerned with determining the efficacy of payoff structures for these kinds of situations.

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Consumption, Savings, and the Meaning of the Wealth Effect in General Equilibrium

Carl D. Lantz and Pierre-Daniel G. Sarte

Over the latter half of the 1990s, the U.S. economy experienced both a substantial decrease in the savings rate and a significant run-up in household net worth. Between 1994 and 2000, the gross private savings rate fell from 17 to 12 percent, while the personal savings rate declined from above 6 percent to less than zero. Over the same period, the value of household sector equity holdings (including those owned by nonprofits, pensions, and other fiduciaries) increased nearly 150 percent for a dollar gain in excess of $6 trillion.

At some level, the decline in savings and the rise in household equity value during that period appeared to point towards a strengthening of the economy. According to the Permanent Income Hypothesis (PIH), households save less in a given period if they expect future increases in their income. Along these lines, the dramatic gain in stock market wealth was thought to partly reflect future opportunities made available to firms by rapid advances in information technology. Both the fall in savings and the rise in net wealth seemed consistent with the rapid growth of consumption during that period.

Despite the rosy outlook implied by the PIH at the close of the decade, the U.S. economy slowed down considerably in 2000. Specifically, the growth rate of per capita consumption fell to 2 percent in the first quarter of 2001 from nearly 7 percent in the same quarter of the previous year. Between the first quarter of 2000 and that of 2001, household net worth fell by 8 percent, or

The views expressed in this article are the authors' and do not necessarily represent those of the Federal Reserve Bank of Richmond or the Federal Reserve System. We wish to thank Michael Dotsey, Margarida Duarte, Thomas Humphrey, and Yash Mehra for helpful suggestions. All errors are our own.

$3.5 trillion. In light of these developments, it seems only natural to question the significance of the data in the late 1990s. With this question in mind, this article seeks to emphasize the following points.

First, the PIH notwithstanding, a fall in savings today may not necessarily reflect expected future gains in income, but rather the current realization of a negative economic shock. Within the context of a simple neoclassical growth model with investment adjustment costs, we show that an unanticipated permanent fall in productivity leads to a contemporaneous fall in both consumption and savings. The fall in savings continues several periods into the future and a lower steady-state level of savings ultimately emerges. It remains true, in this model, that a fully anticipated increase in future productivity also leads to a contemporaneous fall in savings as households seek to smooth consumption. In the latter case, however, the savings rate eventually reaches a higher steady state level as the shock is realized.

Second, it is important to recognize that discussions of the wealth effect, such as those in Ludvigson and Steindel (1999) or Mehra (2001), are often carried out in a partial equilibrium setting. In such a setting, both the rate of interest and the level of wealth are exogenous with respect to contemporaneous consumption (i.e., wealth is a state variable). In contrast, general equilibrium considerations imply that wealth, the rate of interest, and consumption all contemporaneously react to the various disturbances affecting the economy. Thus, an unanticipated permanent increase in productivity leads to a simultaneous rise in both consumption and household net worth. Note, however, that consumption does not respond directly to wealth. Rather, both variables react simultaneously to the higher level of productivity. The implication of this dual reaction is that the *measured* marginal propensity to consume out of wealth is unlikely to be constant, as is often assumed. Indeed, empirical studies such as those in Mehra (2001) and Ludvigson and Steindel (1999) have found that the magnitude of the wealth effect is dependent on the sample period in question. This lack of time consistency in the wealth parameter would be expected if the nature of the shocks impacting the economy was changing over different sample periods.

In general, it can be misleading to think in terms of households' marginal propensity to consume out of wealth. Such thinking presumes that important movements in wealth exist that are independent of economic fundamentals. However, the value of corporate equity reflects the present discounted value of future firm dividends and, in a general equilibrium framework, both the discount rate and dividends respond to changes in the economic environment.

To make matters concrete, we show that consumption and wealth can move in opposite directions in some cases. When a future increase in productivity

is fully anticipated, at the time of anticipation consumption rises while the value of household equity falls. Although households eventually hold more wealth in the new steady state, the initial fall in equity value reflects higher future discount rates consistent with the anticipated increase in productivity. A partial equilibrium framework prohibits this finding from ever arising because the rate of interest is held fixed.[1]

In this article, we first present some basic empirical facts regarding consumption, savings, and wealth in U.S. data. We next outline a simple theoretical framework that allows us to simultaneously explore the price of corporate equity and households' consumption-savings decisions. Finally, we analyze the results from several numerical experiments related to both anticipated and unanticipated shocks to total factor productivity.

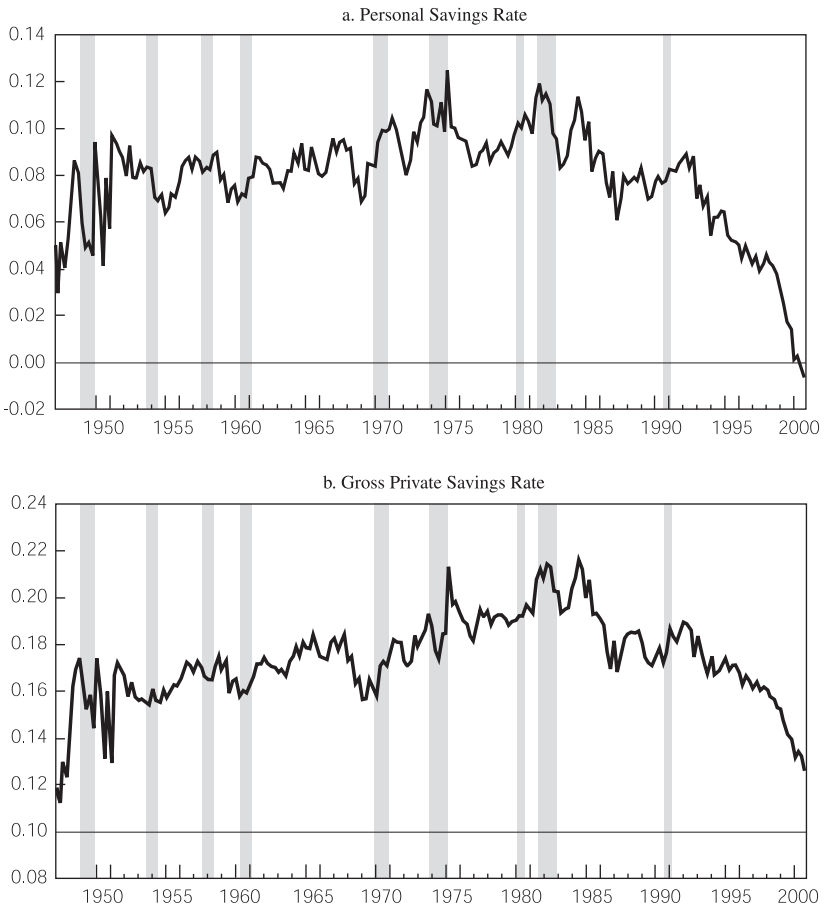
1. CONSUMPTION AND THE SAVINGS RATE IN U.S. DATA

Figure 1 shows the behavior of two alternate measures of the U.S. savings rate over the past 41 years. Panel a of Figure 1 captures the most basic National Income and Product Accounts (NIPA) measure of savings, Personal Disposable Income less Personal Consumption Expenditures in 1996 dollars. The savings rate in panel b is computed using Gross Private Savings which, in addition to Personal Savings, includes retained earnings by firms. We can see that both measures of the savings rate fell drastically over the 1990s and, by early 2001, had reached their lowest recorded levels.

We suggested earlier that a desire to smooth consumption may lead households to save less today if they expect future gains in their income or, alternatively, to save more if they expect future declines in their income. In particular, Hall (1978) argued that the consumption behavior of a household at a given date was based on all of that household's future discounted earnings. Milton Friedman (1957) was perhaps the first to draw a distinction between changes in permanent and transitory income. Figure 2 illustrates (normalized) movements in the savings rate four quarters prior to each of the past five U.S. recessions**.** In panel a, we can see that the personal savings rate generally rises during the year prior to a recession. However, this tendency is not clear-cut. Moreover, it is much less pronounced for the gross private savings rate in panel b. In this case, in the four quarters preceding two of five recessions, the savings rate either falls or remains the same. Figure 3 plots the cross-correlations between our two measures of the savings rate and output at different leads and lags. Both the personal savings rate and the gross private savings rate show a negative correlation with future values of GDP. Hence, there seems to be some evidence to support the PIH. However, the magnitude of the cross-correlations

[1] See Kiley (2000) for a more detailed description of stock price behavior in a production economy versus a partial equilibrium setting.

Figure 1 Measures of Savings

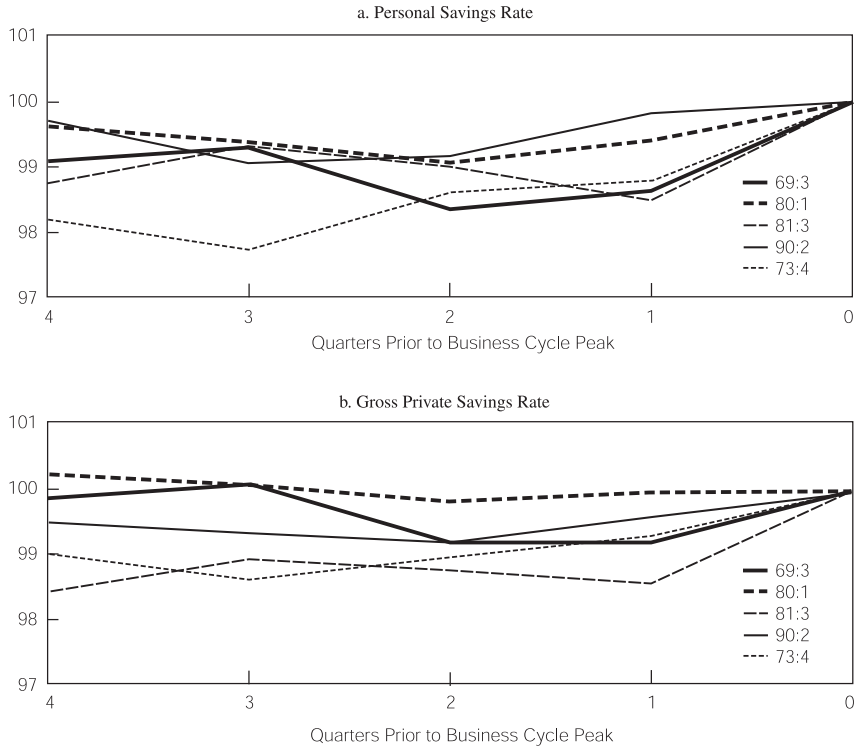


shown in Figure 3 is relatively low, and it is possible that factors other than expectations of future changes in income help drive the behavior of the savings rate.

2. A SIMPLE THEORETICAL PERSPECTIVE

In order to explore some of the issues introduced above, we now describe a model that can be simultaneously used to price corporate equity and address household consumption-savings decisions. For simplicity, we abstract from the inclusion of a noncorporate sector and intangible assets, as well as several aspects of the U.S. tax system. McGrattan and Prescott (2000), however, suggest that these considerations are important in calibration exercises meant

Figure 2 Savings Rate and Equity Price Behavior Prior to Various U.S. Recessions



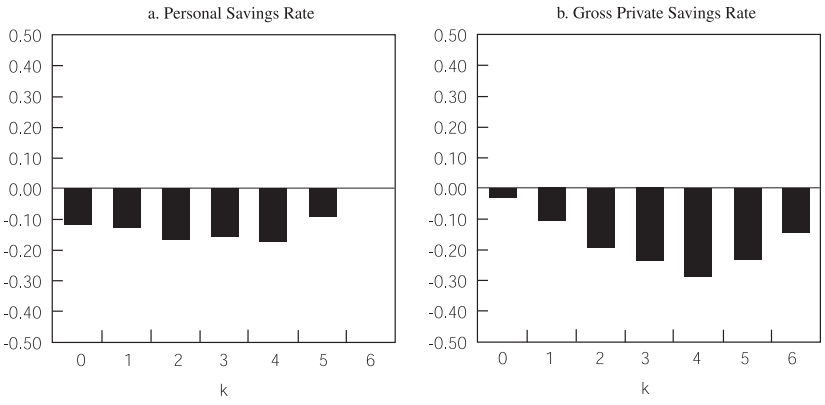
to match data from the NIPA and the *Statistics of Income* (SOI). In particular, the authors argue that the historical behavior of asset prices and returns can be largely explained by changes in tax and regulatory policies as well as by the evolution of the institutions affecting asset markets.

In this model, the economic environment consists of a large number of identical households and firms. Each firm has access to a constant returns technology,

$$y_t = z_t k_t^{\alpha} n_t^{1-\alpha}, \ 0 < \alpha < 1, \tag{1}$$

where y_t is the firm's output at a given date t, n_t denotes labor input, z_t is a random technological shift parameter, and k_t represents the firm's capital stock. In this article, we shall think of firms as owning their capital stock instead of renting it from households. Households will be thought of as owning claims on firms' net cash flows, e.g., equity shares.

Figure 3 HP Filtered Cross-Correlations with Output $\text{corr}[x_t, y_{t+k}]$



Barro and Sala-i-Martin (1995) suggest that if the stock of capital includes a human component, then one will anticipate substantial adjustment costs in investment. According to the authors, "the learning process takes time, and attempts to accelerate the training process are likely to encounter rapidly diminishing rates of return" (p. 119). Hence, we model the evolution of a firm's capital stock as

$$k_{t+1} = (1 - \delta)k_t + \phi\left(\frac{i_t}{k_t}\right)k_t, \tag{2}$$

where $0 < \delta < 1$ is the capital depreciation rate and i_t represents the firm's investment decision at date t. The function $\phi(\cdot)$, with $\phi'(\cdot) > 0$, captures the idea of adjustment costs in investment. Thus, the higher the level of investment relative to the current capital stock, the more costly it becomes to increase next period's capital. Observe that the function $\phi''(\cdot) < 0$ indexes the degree to which adding to the capital stock becomes costly.[2] In addition, note also that the book value of capital at date t, k_t, reflects investment decisions made at date $t - 1$. Therefore, k_t cannot respond contemporaneously to changes in the economic environment. In contrast, if we think of the firm as having a fixed number of equity shares outstanding, the value of these shares can contemporaneously react to disturbances affecting the economy. Put another way, we expect both household net worth and consumption to move simultaneously in response to various shocks.

[2] For an early discussion of this formulation of investment adjustment costs, see Abel and Blanchard (1983).

Firms pay each unit of labor the wage rate w_t, and their net cash flow at t is consequently given by

$$z_t k_t^{\alpha} n_t^{1-\alpha} - i_t - w_t n_t. \tag{3}$$

We assume that this cash flow is paid to households in the form of dividends, D_t. Each firm attempts to maximize the present discounted value of future profits. The representative firm's problem, therefore, can be summarized as

$$\max \sum_{\tau=0}^{\infty} \Pi_{i=-1}^{\tau-1} Q_{t+i} \left[z_{t+\tau} k_{t+\tau}^{\alpha} n_{t+\tau}^{1-\alpha} - i_{t+\tau} - w_{t+\tau} n_{t+\tau} \right], \tag{P1}$$

subject to the sequence of constraints given by (2). In (P1), Q_{t-1} denotes the price of a security that pays one unit of the consumption good at date t.

The solution to the firm's problem must satisfy the following first-order conditions,

$$w_t = (1-\alpha) z_t k_t^{\alpha} n_t^{-\alpha}, \tag{4}$$

$$\lambda_t \phi' \left(\frac{i_t}{k_t} \right) = 1, \tag{5}$$

and

$$\begin{aligned} & Q_t \alpha z_{t+1} k_{t+1}^{\alpha-1} n_{t+1}^{1-\alpha} \\ = \; & \lambda_t - Q_t \lambda_{t+1} \left[(1-\delta) + \phi \left(\frac{i_{t+1}}{k_{t+1}} \right) - \phi' \left(\frac{i_{t+1}}{k_{t+1}} \right) \frac{i_{t+1}}{k_{t+1}} \right], \end{aligned} \tag{6}$$

where $\lambda_t \geq 0$ is the Lagrange multiplier associated with (2). Equation (4) simply equates the wage rate to the marginal product of labor. Equation (5) suggests that it is optimal for the firm to invest up to the point where the cost of one additional unit of investment (in terms of foregone profits) exactly offsets the marginal gain from increasing next period's capital stock.

As mentioned earlier, the representative household owns all firms and receives their profits, D_t, as dividends. At date t, the typical household's net worth, A_t, consists of stock market wealth and bonds. Specifically, we denote the market value of household equity by $V_t X_t$, where V_t represents the price of firms' outstanding equity shares and X_t is the number of shares held by the household. Agents also own one-period bonds, B_t, where a bond purchased at date t pays one unit of the consumption good at time $t+1$. The representative household maximizes its lifetime utility and solves

$$\max \sum_{\tau=0}^{\infty} \beta^{\tau} \frac{c_{t+\tau}^{1-\sigma} - 1}{1-\sigma}, \; \sigma > 0, \tag{P2}$$

subject to the sequence of constraints

$$c_t + V_t X_{t+1} + Q_t B_{t+1} = (V_t + D_t) X_t + B_t + w_t n_t. \tag{7}$$

Household income on the right-hand side of equation (7) stems from the ownership of firms, with dividend earnings given by $D_t X_t$, earnings from bonds, B_t, and labor income, $w_t n_t$. These earnings can be used to purchase consumption goods, new equity shares, and bonds. The first-order conditions associated with the household problem are

$$c_t^{-\sigma} = \psi_t, \tag{8}$$

$$Q_t = \beta \left(\frac{\psi_{t+1}}{\psi_t} \right), \tag{9}$$

and

$$V_t = \beta \left\{ \left(\frac{\psi_{t+1}}{\psi_t} \right) \left[V_{t+1} + D_{t+1} \right] \right\}, \tag{10}$$

where ψ_t is the multiplier associated with the household budget constraint (7). Note that equations (9) and (10) can be used together to yield

$$V_t = \sum_{\tau=1}^{\infty} \Pi_{i=1}^{\tau-1} Q_{t+i} D_{t+\tau}. \tag{11}$$

In other words, the price of a firm's outstanding equity shares reflects the expected present discounted value of its future dividends. In this model, therefore, even shocks that affect only future profit opportunities and discount rates will lead to changes in today's household wealth.

Observe that the multiplier λ_t in (5) can be interpreted as the shadow price of installed capital. In particular, the Appendix shows that equations (6) and (11) can be used to derive

$$V_t = \lambda_t k_{t+1}. \tag{12}$$

Since $\phi''(.) < 0$, an increase in investment leads to a rise in λ_t by equation (5), as well as a rise in k_{t+1}. Hence, in thinking about the effects of various shocks below, we need only keep track of the investment response in order to understand movements in the value of corporate equity.[3]

An equilibrium for the economy we have just presented must satisfy firms' optimality conditions (4) through (6), as well as households' optimality conditions (8) through (10). In addition, the goods market clearing condition,

$$c_t + i_t = y_t, \tag{13}$$

must hold. In equilibrium, we further have that $X_t = X_{t-1} = 1$ for all t and, since households are identical, bonds are in zero net supply, $B_t = 0$ for all t. Equation (13) implies that savings equals investment, $s_t = y_t - c_t = i_t$.

[3] Hayashi (1982) shows that equation (12) always holds when the production technology is constant returns to scale.

Before investigating the joint response of consumption, savings, and wealth to different changes in the economic environment, we must first assign values to the exogenous parameters of our model. Each period represents a quarter, and we set δ and σ to 0.025 and 2 respectively. These values for δ and σ are standard in quantitative studies of business cycles. In the steady state, equations (9) and (11) imply that the price-earnings ratio, V/D, is given by $\beta/(1-\beta)$. Hence, we set β to 0.983 in order to generate a long-run annualized price-earnings ratio of 14.5.[4] We set α to $1/3$ which leads to an investment share in output of 20 percent in the steady state. Finally, we set the parameter that governs the degree of adjustment costs, ϕ'', to -10. This calibration implies that the elasticity of the investment:capital ratio with respect to Tobin's q is approximately 5. Baxter and Crucini (1993) explore a variety of possible calibrations for this elasticity parameter, ranging from 1 to 15, without substantially altering their results. This remains true in our framework.

On the Significance of the Wealth Effect in General Equilibrium

The solution to the model above implies a law of motion for the vector of state variables, s_{t+1} as a function of s_t, where s_t consists of the capital stock, k_t, and the random technological shift parameter, z_t. This solution also links control variables, such as consumption, c_t, and the market capitalization of firms, V_t, to the state variables. Therefore, in a linearized form, we have

$$c_t = c_0 + c_k k_t + c_z z_t \tag{14}$$

and

$$V_t = v_0 + v_k k_t + v_z z_t, \tag{15}$$

where c_0, $v_0, \ldots$ are functions of the deep parameters of the model capturing preferences and technology. Solving for k_t in equation (15) and substituting the resulting expression in (14) yields

$$c_t = \underbrace{(c_0 - \frac{c_k}{v_k} v_0)}_{\text{constant}} + \underbrace{(\frac{c_k}{v_k})}_{\beta} V_t + \underbrace{(c_z - \frac{c_k}{v_k} v_z) z_t}_{u_t}. \tag{16}$$

This last equation often forms the basis of regression equations that are meant to uncover the size of the wealth effect, $\partial c_t / \partial V_t = c_k / v_k = \beta$. Observe that the only source of random disturbances in equation (16) stems from movements in productivity, z_t. Moreover, because changes in equity V_t are necessarily correlated with changes in fundamentals, z_t, it will be important to make

[4] Until recently, this value has been approximately the average implied by the S&P 500 index since 1949.

use of instrumental variables to properly estimate the coefficient β. That being said, since all movements in both c_t and V_t are generated from changes in economic fundamentals, estimates of the marginal propensity to consume out of wealth are of little use in this environment. More to the point, the expression $\partial c_t / \partial V_t$ is meaningful only to the degree that there exist significant exogenous movements in net worth, ∂V_t, that are unrelated to changes in underlying economic conditions. Such movements may reflect, for example, the existence of stock market bubbles. In our environment, however, changes in consumption and wealth are necessarily linked through movements in productivity and given by

$$\begin{aligned} \frac{\partial c_t}{\partial z_t} &= \left(\frac{c_k}{c_v}\right)\frac{\partial V_t}{\partial z_t} + \left(c_z - \frac{c_k}{v_k} v_z\right) \\ &= c_z. \end{aligned} \tag{17}$$

3. NUMERICAL EXAMPLES

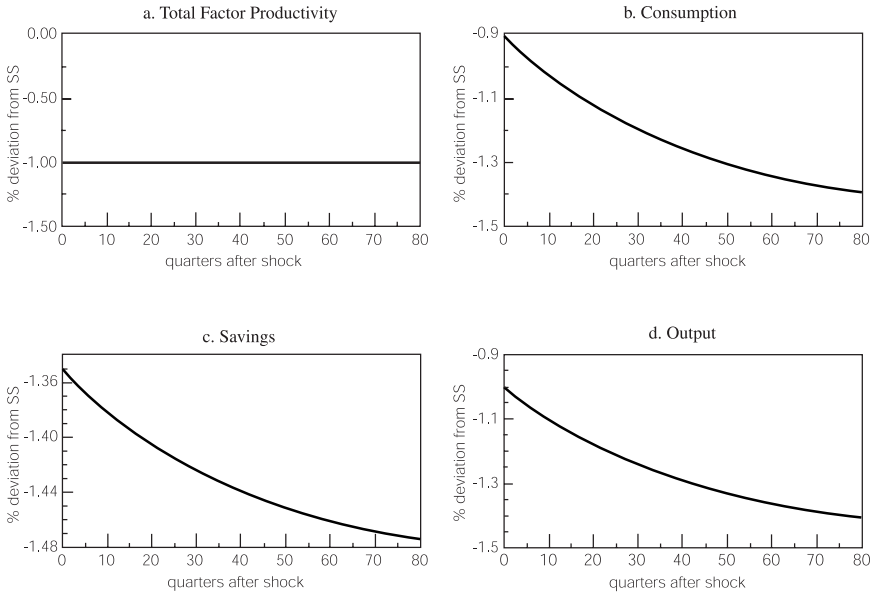
We will now explore the behavior of our economy when the underlying source of uncertainty lies in total factor productivity, z_t. We shall examine the effects of both unanticipated and anticipated changes in productivity, and outline significant differences in the way the economy reacts to these shocks. To emphasize these differences, we shall also compute the cross-correlations of consumption and the savings rate with stock market wealth under both these parameterizations of productivity shocks.

The Effects of Unanticipated Shocks in Productivity

Figure 4, panel a, depicts an unanticipated and permanent 1 percent fall in productivity. As a result of this shock, output falls immediately as depicted in Figure 4, panel d, and continues falling towards a lower steady state value. Observe that both consumption and savings mimic the output response. Both variables fall at the time of the shock and eventually reach a lower steady state level. In this case, therefore, a fall in savings does not indicate better times ahead, as a naive interpretation of the PIH suggests. Instead, by allowing households to consume some of their capital, diminished savings behavior softens the fall in consumption. It remains true, of course, that the economy is unambiguously worse off in the long run.

In this numerical experiment, the savings rate decreases dramatically on impact and then *rises* on its way to the final steady state. This is shown in Figure 5, panel b. In the new long-run equilibrium, however, the savings rate is ultimately lower relative to its level in the period prior to the shock. This example suggests that it may be difficult to identify the source of a given decline in the savings rate in the data. In particular, we shall see below that one version of the PIH continues to hold in general equilibrium. That is,

Figure 4

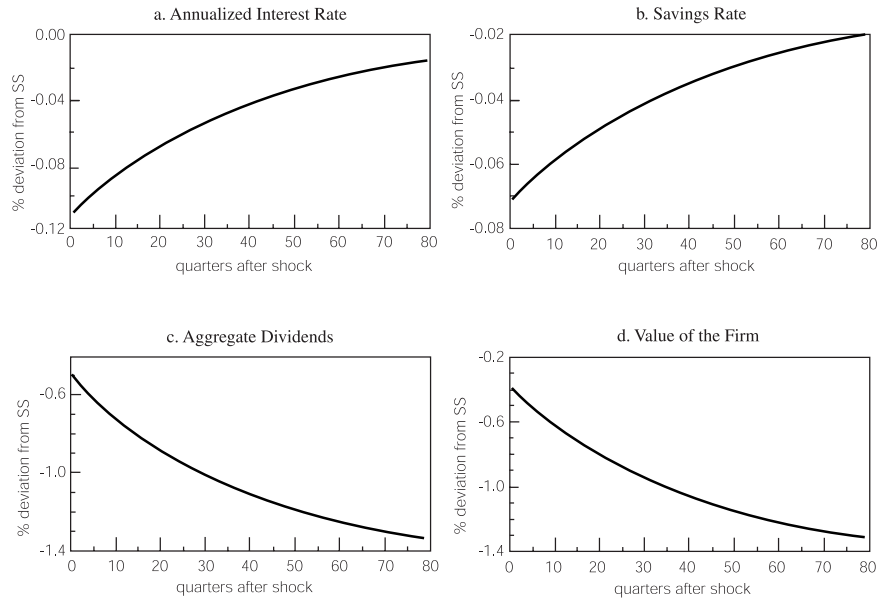


an anticipated increase in future productivity also leads to a decrease in the savings rate today, followed by a gradually increasing path. In the case of this anticipated increase, however, the savings rate eventually increases all the way to a *higher* steady state level.

Figure 5 also shows that the interest rate, firms' dividends, and the market value of equity all decrease when the negative productivity shock is realized. Given equation (12), the fall in equity is relatively easy to follow. Because the level of savings falls in response to the shock, firms are forced to cut back on investment, which directly leads to a decrease in the value of corporate equity. Note that this decline in equity is consistent with the fall in aggregate dividends in Figure 5, panel c, but is mitigated by the decrease in interest rates during the transition to the new steady state. Since the rate of interest is simply the inverse of Q_t in equation (9), the steady fall in consumption in Figure 4, panel b, indeed implies a decline in interest rates until the new long-run equilibrium is reached.

Finally, in this example, Figures 4b and 5d show that consumption and wealth respond to the shock in the same direction. As we have already pointed out, however, it should be clear that there is no sense in which consumption responds directly to movements in wealth. Furthermore, the nonlinearity of the impulse responses implies that the measured marginal propensity to consume out of wealth will not be constant in this case. This implication is at variance

Figure 5



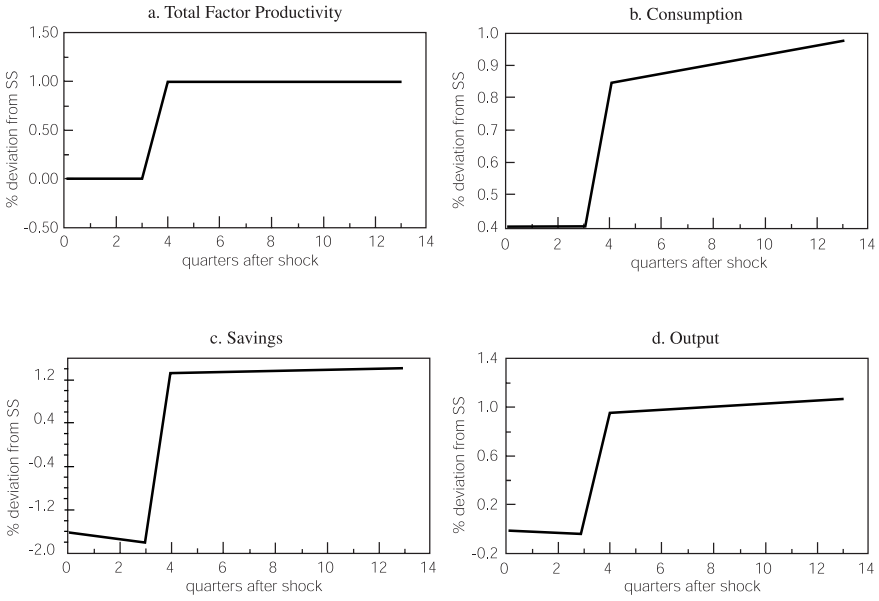
with studies, such as Davis and Palumbo (2001) and Poterba and Samwick (1995), that have attempted to measure the additional increase in consumption stemming from a rise in household equity.

The Effects of Anticipated Changes in Productivity

We now study the model economy's response to an anticipated permanent positive shock to total factor productivity. One interpretation of such a shock may involve the conception of a new technology whose actual implementation is likely to take time. We shall see that in the short run, there exist similarities in the way savings respond to an anticipated positive shock and an unanticipated negative shock. These similarities, while they can make the interpretation of savings data ambiguous at times, eventually dissipate in the long run.

Figure 6, panel a, depicts a 1 percent positive shock in total factor productivity that takes place four periods in the future. This shock, however, is fully anticipated by both households and firms in the current period. Because productivity, and thus output, is expected to increase, household consumption immediately rises in Figure 6, panel b. This response reflects a desire to smooth consumption that is implicit in the household problem. However, since the capital stock, k_t, is fixed at time zero, output cannot change at the

Figure 6



time of the shock. It must be the case, therefore, that savings initially fall in a way consistent with the PIH, as shown in Figure 6c.

Observe that because the initial increase in consumption is sustained until the productivity shock takes place, the level of savings continues to fall in the short run. Therefore, as households find it optimal to temporarily consume part of the capital stock, output declines between period 0 and period 4. Once the positive productivity shock occurs in period 4, consumption, savings, and output all increase and begin converging towards their new steady state. In our context, adjustment costs limit the extent to which households wish to increase consumption initially. To be specific, since firms will find it optimal to increase investment once the shock occurs, and the marginal product of capital will consequently rise, it will be important that the capital stock not be too low at the point of the shock. Recall that the nature of investment adjustment costs is such that the higher the level of investment relative to the current capital stock, the more costly it becomes to increase the next period's capital.

Figure 7

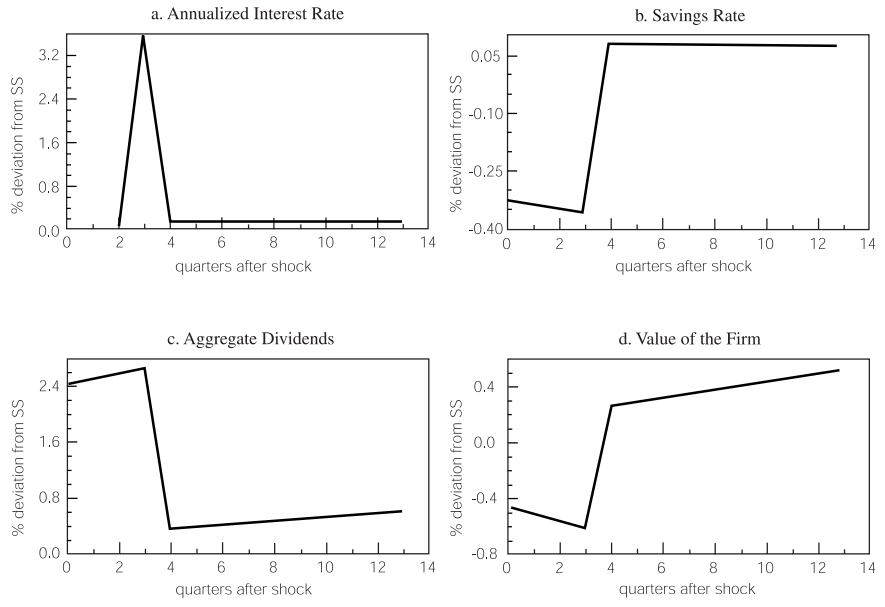
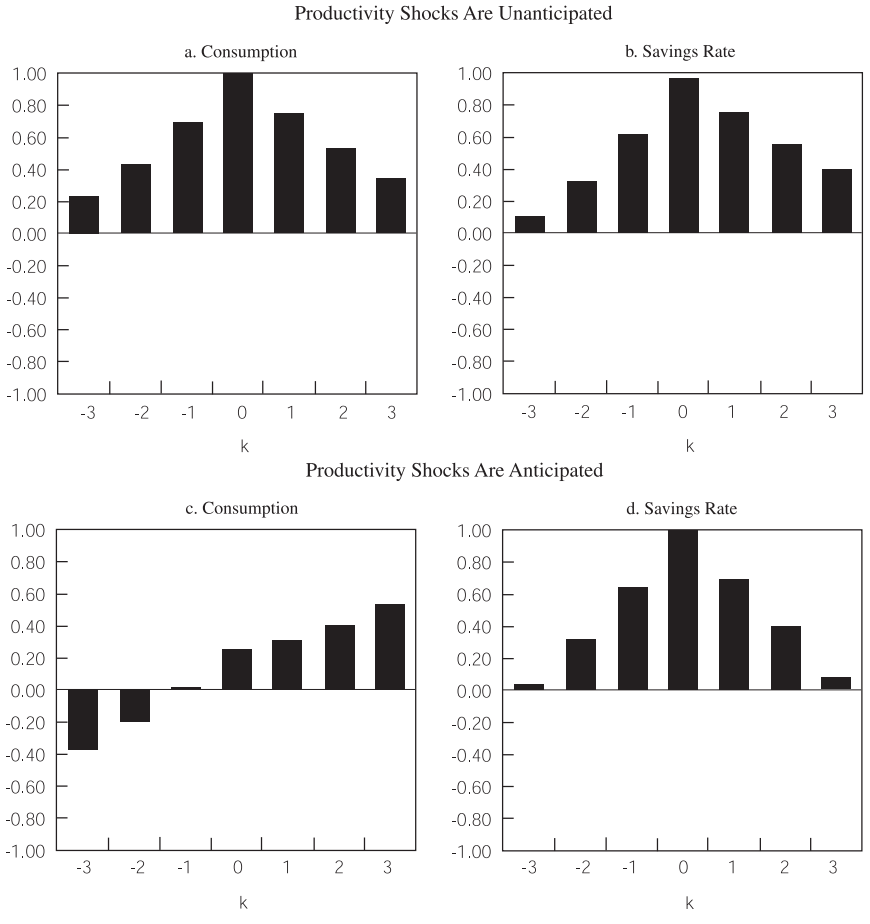


Figure 7, panel d, shows that the value of corporate equity actually falls when the productivity shock is anticipated at time zero. This result can be most easily understood in terms of the fall in savings in Figure 6c and the resulting decline in investment. More importantly, this finding clearly indicates that consumption, as shown in Figure 6b, and wealth do not have to move in the same direction. This result is at odds with many empirical studies in which consumption always responds positively to wealth within the assumed theoretical framework. On a related note, the impulse responses depicted in Figures 6 and 7 suggest that the data in the late 1990s were not necessarily indicative of a future strengthening of the economy. As we pointed out in our introduction, both consumption and wealth rose during that period while savings fell. Our numerical experiment suggests that an anticipated positive shock to productivity, while leading to a fall in savings and a rise in consumption during the current period, generates a fall in wealth initially.

Finally, Figure 7, panel a, illustrates a remarkable increase in the interest rate in the period prior to the realization of the shock. This noticeable increase is consistent with the jump in consumption that occurs in the next period when the shock takes place. In particular, the high rate of interest prevents consumption from rising too dramatically in anticipation of the productivity increase. Moreover, observe that the interest rate spike is also consistent with

Figure 8 Model-Generated Cross-Correlations with Wealth
corr$[x_t, V_{t+k}]$



the initial fall in wealth in Figure 7c. Once the shock has occurred, the high rate of interest depicted in Figure 7a is no longer part of the present discounted value calculation with respect to future earnings. As a result, the value of corporate equity increases markedly.

Implied Cross-Correlations between Consumption, Savings, and Wealth

Thus far, we have seen that the nature of productivity shocks, whether they are anticipated or unanticipated, has significant implications for the reactions of

key economic variables. In particular, we have seen that wealth and consumption do not always have to respond in the same direction to a given productivity shock. We will emphasize this point below by showing important differences in the cross-correlation pattern of the data generated under each type of shock.

Figure 8 presents the cross-correlations of consumption and the savings rate with stock market wealth generated by the model. As in the real-business-cycle literature, we first assume (in Figures 8a and 8b) that the dominant source of uncertainty lies in productivity shocks, which we calibrate as

$$\ln z_t = \rho_z \ln z_{t-1} + \varepsilon_{zt}, \tag{18}$$

where $\rho_z = 0.95$ and ε_{zt} is an i.i.d. normal random variable with mean zero and standard deviation 0.01. The model statistics depicted in Figure 8 are the mean values calculated from 200 simulations of samples with 216 observations each, the number of quarterly observations in postwar U.S. data. Figures 8c and 8d present the same cross-correlations under the assumption that all productivity shocks are anticipated four periods in advance.

As we can see from the simulations in Figure 8, the cross-correlation patterns of consumption and savings with wealth are quite different depending on the nature of productivity shocks. When shocks are unanticipated, the contemporaneous correlation between consumption and wealth is very near 1. This contemporaneous correlation, however, is much lower at 0.25 when productivity shocks are anticipated. Therefore, to the degree that the U.S. economy is continuously hit by a variety of shocks that are both unanticipated and anticipated—to technology, preferences, or even public expenditures—and whose processes may have changed over time, it is unlikely that a regression of consumption on wealth would uncover a stable coefficient over different sample periods.

Finally, it is important to recognize that the cross-correlation patterns depicted in Figure 8 may change significantly with the particular model at hand. For instance, Constantinides (1990) and Abel (1990) suggest that habit formation is an important factor in explaining consumption behavior. When subject to habit formation, consumption reacts to various shocks only with a lag, and this lag may be essential in helping us understand U.S. consumption data. In addition, the model we have examined does not allow for the presence of credit-constrained households. For these households, consumption may be more tied to current income and wealth than is suggested by permanent income households.

4. CONCLUDING REMARKS

At the close of the 1990s, the U.S. economy experienced declining savings, a rise in household equity value, and rapidly growing consumption. At some level, this data appeared indicative of a strengthening economy going forward. The Permanent Income Hypothesis (PIH) indeed suggests that savings should fall in the current period if increases in income are expected in the future and that the fall in savings would simply reflect households' desire to smooth consumption.

Contrary to this optimistic scenario, the U.S. economy slowed down considerably in 2000. Consequently, it seems natural to reevaluate the significance of the data in the late 1990s. With this task in mind, we have stressed the following points.

First, the PIH notwithstanding, a fall in savings does not necessarily reflect the expectation of future gains in income but can instead reflect the current realization of an unanticipated, negative economic shock. In the case of an unanticipated decline in productivity, the level of savings continues to fall until it reaches a lower steady state level. In contrast, in response to an anticipated positive shock to future productivity, savings eventually rise to a higher steady state level even if they fall initially.

Second, we have attempted to make clear that consumption and wealth simultaneously react to fundamental changes in the economic environment. In a general equilibrium context, there is no sense in which consumption responds directly and positively to changes in wealth. The latter notion has, in fact, been the starting point for many empirical studies, but we have shown that when a future increase in productivity is fully anticipated, consumption and wealth may initially move in *opposite* directions. Furthermore, because both the consumption and wealth responses to productivity disturbances are nonlinear, the measured marginal propensity to consume out of wealth is unlikely to be constant. In light of these results, the data on consumption, savings, and wealth in the late 1990s should not necessarily have been interpreted as presaging a future strengthening of the economy. Our numerical experiments suggest that an anticipated rise in productivity, while leading to a fall in savings and an increase in consumption in the current period, initially generates a short-run decline in wealth. The last response is at odds with the behavior of wealth at the end of the last decade.

APPENDIX: DERIVATION OF TOBIN'S q

This appendix describes the derivation of equation (12) in the text. Specifically, multiplying both sides of equation (6) by $k_{t+1} \geq 0$ yields

$$\begin{aligned}\lambda_t k_{t+1} &= Q_t \alpha y_{t+1} + Q_t \lambda_{t+1} \left[(1-\delta) k_{t+1} + \phi \left(\frac{i_{t+1}}{k_{t+1}} \right) k_{t+1} \right] \\ &\quad - Q_t \lambda_{t+1} \phi' \left(\frac{i_{t+1}}{k_{t+1}} \right) i_{t+1}.\end{aligned}$$

In this last expression, $\left[(1-\delta) k_{t+1} + \phi \left(i_{t+1}/k_{t+1} \right) k_{t+1} \right]$ is simply k_{t+2} while $\lambda_{t+1} \phi' \left(i_{t+1}/k_{t+1} \right) = 1$ by equation (5). Therefore,

$$\lambda_t k_{t+1} = Q_t \underbrace{\left[y_{t+1} - w_{t+1} n_{t+1} - i_{t+1} \right]}_{D_{t+1}} + Q_t(s_{t+1}) \lambda_{t+1} k_{t+2}$$

since $\alpha y_{t+1} = y_{t+1} - w_{t+1} n_{t+1}$. By repeatedly substituting for $\lambda_{t+j}\ k_{t+j+1}$, $j \geq 1$, we have

$$\sum_{\tau=1}^{\infty} \Pi_{i=0}^{\tau-1} Q_{t+i} D_{t+\tau} = \lambda_t k_{t+1},$$

where $\sum_{\tau=1}^{\infty} \Pi_{i=0}^{\tau-1} Q_{t+i} D_{t+\tau}$ is simply V_t by equation (11) in the text. Thus, λ_t has the interpretation of Tobin's q.

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