References

Davis, P. and G.F. Papanek (1984) 'Faculty ratings of major economics departments by citations', *American Economic Review* 74: 225–230.

Graves, P.E., J.R. Marchand and R. Thompson (1982) 'Economics departmental rankings: Research incentives, constraints and efficiency,' *American Economic Review* 72: 1,131–1,141.

Kalaitzidakis, P., T.P. Mamuneas and T. Stengos (2003) 'Rankings of academic journals and institutions in economics', *Journal of the European Economic Association* 6: 1,346–1,366.

Katz, M.L. and C. Shapiro (1985) 'Network externalities, competition, and compatibility,' *American Economic Review* 75: 424–440.

Laband, D.N. and M.J. Piette (1994) 'The relative impacts of economics journals, 1970–1990,' *Journal of Economic Literature* 32: 640–666.

Laband, D.N. and Robert D. Tollison (2000) 'On secondhandism and scientific appraisal,' *Quarterly Journal of Austrian Economics* 3: 43–48.

Laband, D.N. and Robert D. Tollison (2003) 'Dry holes in economic research,' *Kyklos* 56: 161–173.

Laband, D.N. and Robert D. Tollison (2004) 'Dry holes in academic research: Reply,' *Kyklos* 57: 627–628.

Leibowitz, S.J. and J.P. Palmer (1984) 'Assessing the relative impacts of economics journals,' *Journal of Economic Literature* 22: 77–88.

Leibowitz, S.J. and S.E. Margolis (1994) 'Network externality: An uncommon tragedy,' *Journal of Economic Perspectives* 8: 133–150.

Lo, M., M.C.S. Wong, and F.G. Mixon, Jr. (2008) 'Ranking economics journals, economics departments and economists using teaching-focused research productivity,' *Southern Economic Journal* 74:894–906.

Mayer, T. (2004) 'Dry holes in academic research: Comment,' *Kyklos* 57: 621–625.

Mixon, F.G., Jr. (ed) (2005) *Shaping the Learning Curve: Essays on Economic Education*, New York: iUniverse, Inc.

Contact details

Professor Franklin G. Mixon, Jr.
Department of Economics
Auburn University
Auburn, AL 36849
USA

Email: fgm0003@auburn.edu

Professor Kamal P. Upadhyaya
Department of Economics & Finance
University of New Haven
West Haven, CT 06516
USA

Email: kupadhyaya@newhaven.edu

A Classroom Inflation Uncertainty Experiment*

Denise Hazlett

Abstract

This classroom experiment uses a double oral auction credit market to demonstrate how inflation uncertainty causes a wealth transfer between borrowers and lenders. The experiment also shows the social cost of inflation uncertainty when borrowers and lenders cannot agree on a nominal interest rate that compensates each for their risk. In this case, the credit market fails to allocate funds to the highest-valued investment projects. The experiment provides hands-on experience with the effects of anticipated and unanticipated inflation, giving students a common background for a discussion of the economic costs of inflation. It can be used in principles, intermediate macroeconomics, money and banking, or financial economics courses, with 8–60 students. It takes approximately 50 minutes to run and requires no computers.

The author gratefully acknowledges Jeffrey Parker's help designing the inflation uncertainty experiment, and the funding provided by a grant from Will and Susanna Thomas and from the Sally Ann Abshire Research Scholar Award. She also thanks Noelwah Netusil for her helpful suggestions.

Introduction

This paper describes how to run and debrief a classroom experiment that demonstrates some of the economic costs of inflation uncertainty. In the experiment, students take the roles of potential borrowers and lenders in a double oral auction credit market. Borrowers have the opportunity to undertake investment projects with relatively high real returns. However, they have no funds of their own with which to finance their projects. Lenders do have funds. Lenders also have the opportunity to undertake investment projects, but their projects have relatively low real returns. Gains from trade reach their maximum when all of the lenders agree to lend their funds to the borrowers, so that the highest-valued projects get financed.

Borrowers and lenders contract for loans in nominal terms. Their payoffs depend on the real returns on their loans, which in turn depend on the inflation rate. In the first few periods, borrowers and lenders know what the inflation rate will be. In later periods, they find out the inflation rate after they contract for their loans. Over the last few periods, the inflation rate becomes progressively more variable. This variability makes the loans risky. For instance, unexpectedly low inflation benefits lenders, but harms borrowers. Unexpectedly high inflation has the opposite effects. The experiment demonstrates these welfare effects. It also shows that if some participants exhibit risk aversion, then inflation uncertainty can prevent the credit market from operating effectively. That is, when a borrower and lender cannot agree on a nominal interest rate that provides enough of a risk premium for each of them, they do not arrange a loan. So, instead of lending their funds to those with higher-valued projects, lenders finance their own lower-valued projects. The foregone gains from trade constitute a social cost of inflation uncertainty.

Participating in this experiment gives students hands-on experience with some of the costs of inflation described in the economics literature. For instance, Hess and Morris (1996) describe how unexpected inflation leads to a transfer of wealth between lenders and borrowers. In the experiment, students experience this wealth transfer, making an otherwise abstract concept come alive. Briault (1995) observes that the likely effects of inflation uncertainty include the increased attractiveness of real (as opposed to nominal) assets as a hedge against inflation. In the experiment, investment projects have real returns independent of the inflation rate. For someone who has funds, undertaking his own project looks attractive compared to a nominal loan that exposes the lender to the risk of high inflation. Borrowers, as they negotiate with the lenders, see that increased inflation uncertainty makes it increasingly harder to convince these people to lend their funds. What's more, even as the lenders ask for higher nominal interest rates as compensation for their risk, borrowers want to pay lower rates to protect *themselves* against the risk of low inflation. The experiment drives home the idea that it's inflation uncertainty that causes this impasse, not inflation itself. That is, in the periods when the inflation rate is perfectly predictable, the credit market channels funds as if there were no inflation at all. But as the inflation rate becomes more and more variable, the flow of funds starts drying up, so that the market no longer channels funds to their best use.

Running the experiment

I recommend running the experiment before discussing the costs of inflation. The experiment thereby introduces the difference between anticipated and unanticipated inflation and provides a common background for students who often have little real-world experience with variable inflation. The experiment typically requires 45 to 50 minutes, depending on the class size and whether students have previous experience with a double oral auction. Larger classes require more time, mainly for the recording of loans on the board. In a class of 30 or more students, the instructor will probably want to arrange for an assistant to help record loans, so that the experiment can be completed in 50 minutes.

As background for the experiment, students need to know the Fisher equation. So, in a class meeting before the experiment, the instructor explains that the real interest rate is (approximately) the nominal interest rate minus the inflation rate. To make sure students can work with this Fisher relationship, I suggest assigning the homework problem in Table 1.

On the day of the experiment, the instructor clears space in the classroom to use as the trading floor, and makes sure that students have enough room to move from the trading floor to the blackboard to report their results. As students enter the classroom, the instructor gives each a private information slip establishing that person's role in the experiment. The slip indicates the real interest rate on that student's project, and whether the student starts each period with funds of $100 or $0. Before passing out the slips, the instructor asks students to keep their project's real return confidential. Table 2 shows a sample private information slip for a potential lender, someone who starts each period with $100. Table 3 shows a sample private information slip for a potential borrower, someone who starts each period with $0. For the purpose of recording the experimental results, each student gets a unique experimental ID. To prevent confusion, lenders have ID letters and borrowers have ID numbers.

See the Appendix for the experiment instructions. These instructions, as well as the other materials for running the experiment in classes of 8–60, are available from the author upon request. The instructor distributes the instructions and reads them aloud, while inviting students to ask questions. The instructor also distributes the student record-keeping sheet in Table 4, which describes the process for calculating

Table 1: Homework assignment to prepare students for the experiment

Suppose Lisa lends to Brad at an annual nominal interest rate of 7%.

(a) If both people expect the inflation rate to be 3% over the coming year, what real interest rate do they expect on the loan?

(b) If the actual inflation rate turns out to be 1%, what real interest rate does Brad actually pay on the loan?

(c) Who is harmed and who is benefited by inflation that is lower than anticipated? Explain.

Table 2: Sample private information slip for a lender

Your ID letter is A.
Your project provides a real interest rate of 1.5%.
You start each period with $100.

Table 3: Sample private information slip for a borrower

Your ID number is 1.
Your project provides a real interest rate of 2.5%.
You start each period with no funds.

profits and allows students to track their results. Note that profits do not carry over from one period to the next. For simplicity, each period is completely separate from the last.

Once the instructor opens the trading period, borrowers and lenders will stand up and mingle, using a double oral auction to arrange their loans. That is, lenders call out offers to lend at nominal interest rates they specify. Similarly, borrowers call out offers to borrow at nominal interest rates they specify. Any lender may accept any borrower's offer, and vice versa. All loans must be for exactly $100, and each project can be undertaken at most once per period. After a borrower and lender arrange a loan, they come to front of the room to report the nominal interest rate on their loan and their experimental IDs. The instructor records this information on the board for all to see. These students then take seats on the edge of the trading floor to indicate that they have finished for that period. After everyone who wishes to has traded, the instructor announces the end of the period. When the instructor begins the next period, everyone will again start with the amount of funds indicated on their information slip, and the opportunity to undertake their project. Regardless of the inflation rate, the project will always have the real return shown on the slip.

For the first two or three periods, the instructor announces before the period begins that the inflation rate will be zero. Running these initial periods with zero inflation establishes the equilibrium nominal (and real) interest rate in the absence of inflation. Consider, for instance, Table 5, which shows project values for a class of 16. In the periods when these participants know there will be no inflation, nominal interest rates between 1.5% and 2.5% will make the quantity demanded of loans equal the quantity supplied, at a quantity of eight. So, in equilibrium nominal (and real) interest rates range between 1.5% and 2.5%, and all of the funds get lent. Those with funds are willing to lend at rates in this range because they earn more from the loans than

Table 4: Student record-keeping sheet

Period	ID of lender	ID of borrower	Nominal interest rate on your loan	Inflation rate	Real interest rate on your loan	If you lent: profits are the real interest rate on your loan	If you borrowed: profits are the real interest rate on your project minus the real interest rate on your loan	If you did not borrow and have no funds: profits are 0	If you invested your own $100 in your project: profits are the real interest rate on your project
			i	π	$r = i - \pi$				
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									
17									
18									
19									
20									

they would if they took their own projects. Those without funds are willing to borrow at these rates because they finance projects that provide higher returns than they pay on the loans. With all of the funds flowing to those with the higher-valued projects, the credit market achieves the maximum possible gains from trade.

It generally takes two or three periods for the market to reach equilibrium. Once all (or most) of the interest rates have converged to the equilibrium range, the instructor announces that, in the next period, the inflation rate will be 4% with certainty. Now, nominal interest rates between 5.5% and 6.5% will make the quantity demanded of loans equal the quantity supplied. So in equilibrium, real interest rates still range between 1.5% and 2.5%, all eight loans get made, and the credit market channels funds to the highest-valued projects.

In this period with perfectly anticipated inflation of 4%, most borrowers and lenders will simply adjust their nominal interest rate bids and offers up by about 4%. However, some students may be confused about what to do. Before trade begins, the instructor can help students understand what their nominal interest rate offers will translate to in real terms by writing the Fisher approximation on the board ($r = i - \pi$), filling in 4% for the inflation rate ($r = i - 4\%$) and pointing out that 'you know for sure that the real interest rate on a loan will be 4% less than the

Table 5: Lenders and borrowers: information for a class of 16

ID	Funds	Real interest rate on project
A	$100	1.5
B	$100	1.0
C	$100	1.5
D	$100	1.5
E	$100	1.5
F	$100	1.0
G	$100	1.0
H	$100	1.0
1	no funds	2.5
2	no funds	3.5
3	no funds	4.5
4	no funds	3.0
5	no funds	3.5
6	no funds	4.0
7	no funds	5.0
8	no funds	3.0

nominal interest rate'. Sometimes students realise they are confused only after they start calculating their profits at the end of this period. At this point, it helps if the instructor demonstrates on the board how to calculate the real interest rate on one of the loans made in this period. So, the instructor takes an actual loan (which students reported in nominal terms) and demonstrates what that loan means in real terms. For example, consider a loan with a nominal interest rate of 6.0%. It has a real interest rate of 6.0% – 4.0% = 2.0%. Most students find their confusion resolved when they see this example, and they can finish calculating their profits. However, the instructor should circulate as students are recording their profits, to provide individual help to any who remain confused. In particular, a student who chooses not to lend or borrow in this period is not maximising their profit, a sign that person needs more help understanding what's going on. The instructor can discreetely show this student an example of what their profit would have been if they had accepted one of the loan offers made that period.

Consider, for example, a potential borrower with a project that has a 4.5% real return. The instructor could point out that: 'Borrowing at 6.0% would give you profit equal to the real return on your project minus the real interest rate on the loan: 4.5% – 2.0% = 2.5%. This 2.5% profit is better than the zero you get if you don't borrow and therefore can't take your project.' Similarly, consider a potential lender with a project that has a 1.5% real return. The instructor could point out that: 'Lending at 6.0% gives you more profit than you get from taking your own project. Lending gives you a 2.0% real return, whereas taking your own project gives you only 1.5%.' It generally takes two periods for everyone to understand and the market to reach equilibrium.

Note that if the class has an uneven number of students, then there will be an extra lender or borrower. In this case there will always be one person not contracting each period, even in equilibrium.[1]

The instructor introduces inflation uncertainty by announcing before the next period begins that the inflation rate will be either 3%, 4% or 5%, with equal probability. After everyone has negotiated their loans, the instructor randomly generates the inflation rate by asking a student to roll a die. The inflation rate for that period is whichever number (3, 4 or 5) comes up. On a 1, 2 or 6, the student would re-roll. Because students enjoy the casino-like tension during the roll, it helps to use a fairly large die that most of the class can see.

In later periods the instructor introduces even greater inflation uncertainty: 2%, 3%, 4%, 5% or 6%, with equal probability. If time permits the instructor can increase inflation uncertainty even further, always maintaining the expected inflation rate of 4%. The rates could even include deflation. For example the inflation rate could be

–1%, 0%, 1%, 2%, 3%, 4%, 5%, 6%, 7%, 8%, or 9%, with equal probability. In this case, the instructor can switch to a twelve-sided die, or draw from a deck of playing cards.

After the experiment ends, the instructor randomly selects one period to provide payoffs. Knowing that only one period will provide payoffs prevents students from viewing the multiple periods as an opportunity to diversify their risk. The instructor distributes profits in the form of one small individually-wrapped chocolate, for each 0.5% of profit earned that period. To cover potential losses, the instructor stakes each student three pieces of chocolate, as described in the instructions.

When the instructor introduces inflation uncertainty, risk-averse lenders will want higher nominal interest rates, and risk-averse borrowers will want lower rates, as compensation for their inflation risk. Those traders with a high degree of risk aversion, or the traders with the least to gain from a loan (the borrower with the 2.5% and the lender with the 1.5% real return on the project) may not find a mutually acceptable nominal interest rate. The lenders would then opt to finance their own projects, making overall gains from trade fall as their lower-valued projects replace the borrowers' higher-valued projects. On the other hand, undertaking a loan provides for positive expected profits, which may overcome the disadvantage of the risk. Moreover, many students like to gamble. They look forward to the tension as the die rolls across the floor, on its way to determining the inflation rate for that period. Finally, because the experiment has students gambling with a small amount of chocolate profits, they may exhibit more risk-loving behavior than they would if they had a large percentage of their wealth at stake. So, whether inflation uncertainty prevents the credit market from operating efffectively depends on the participants and their attitudes toward risk.

Students often do display enough risk aversion for the results to show that increasing inflation uncertainty reduces the credit market's ability to channel funds to their best use. However, sometimes even with highly variable inflation, none of the students display the risk-averse behavior typical of a borrower or lender with a lot at stake. In this case, the instructor can inspire that behavior by introducing a variation towards the end of the experiment. The instructor announces before the next period begins that participants have been making their lending or borrowing decisions as part of their jobs. Their bosses have become concerned about the losses that some of these people have incurred. So, anyone making a loss in the next period will lose their job. The instructor explains that a person making a loss will have to sit out for the rest of the experiment, and someone who did not make a loss that period will take over their role. For instance, suppose the inflation rate turns out to be 2.0%. Consider a borrower with a 3.5% real project return who borrowed at a nominal interest rate of 6.5%. They paid a real interest rate of 4.5%, and made a loss of 1.0%.

Before beginning the next period, the instructor transfers this student's slip and record-keeping sheet to a borrower who did not make a loss that period, effectively promoting that person to the position of running multiple projects.

Results

Table 6 shows the results for an intermediate macroeconomics class of 16 students who had the project values listed in Table 5. Three-quarters of the students in this class had never before participated in a classroom experiment. The information on loans appears as I recorded it on the board, with the borrower's ID number listed first, then the lender's ID letter, and the nominal interest rate. The IDs of those who neither lent nor borrowed do not appear in the table. In this session, Periods 6–9 had variable inflation. For these periods, the actual inflation rate appears underlined. I ran the job-loss variation in Periods 8 and 9. In Period 8, Borrowers 1 and 8 each incurred a loss, so I transferred responsibility for their projects to two other students in Period 9. It took 45 minutes to run the experiment, including reading the instructions.

In each of Periods 2–6, the credit markets operated efficiently, moving funds from the eight lenders, with their lower-valued projects, to the eight borrowers, with their higher-valued projects. Typically, in the first period of a classroom experiment, students are still figuring out how things work. Being in that learning phase probably explains why Borrower 4 and Lender E could not agree on a loan in Period 1, even though theory suggests they should. Any interest rate between 1.5% and 3.0% would have provided gains from trade for both of them. However, by Period 2, all the interest rates had reached the equilibrium range, and everyone was contracting for loans, just as theory predicts. I ran a third period with zero inflation, to make sure all the students understood what they were doing, before moving on to the phase of the experiment with positive and completely predictable inflation. In Periods 4 and 5, all the interest rates again fell within the equilibrium range, and everyone contracted for loans, as theory predicts.

In Period 6, the first period with inflation uncertainty, everyone still contracted for loans, although they did so at higher interest rates than in the previous period. Because the inflation rate turned out to be 5% in Period 6, Lenders E and F, who both lent at 5.9%, each received a real return of only 0.9%. If they had protected themselves from inflation uncertainty by funding their own projects, E and F would have achieved real returns of 1.5% and 1.0% respectively. Lenders A and D, who both lent at 6.0%, also ended up worse off than they would have been if they had taken their own projects. When inflation uncertainty increased in Period 7, Lenders E and F opted to take their own projects rather than lending. All the other lenders,

Table 6: Results for an Intermediate Macroeconomics class of 16 students

Period	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8 Job loss**	**9 Job loss**
Inflation rate	0%	0%	0%	4%	4%	3,4,**5**%	2,3,4, **5**,6%	1,2,**3**,4, 5,6,7%	0,1,2,3,**4**, 5,6,7,8%
Loans	7A 3.0%	7D 2.5%	7D 2.2%	2A 6.0%	1G 5.5%	5A 6.0%	1A 7.0%	1H 7.0%	8F 6.5%
	5F 3.0	4F 2.5	1A 2.0	8D 6.2	2A 5.5	1G 6.0	7G 6.5	2A 6.5	2A 6.5
	2G 2.5	5A 2.0	5G 2.25	4H 6.0	5B 5.5	4D 6.0	5C 6.5	5C 6.5	5G 6.5
	6D 2.5	2C 2.0	3B 2.5	5C 6.0	6F 5.7	3B 6.1	3B 6.5	3G 6.8	3C 6.8
	8H 2.5	1B 2.25	4F 2.3	6E 6.0	4D 5.7	6F 5.9	6D 6.8	8B 6.4	1H 6.5
	1B 2.0	6E 2.5	6C 2.2	7F 5.5	8C 5.5	8E 5.9	8H 6.6	6F 6.7	
	3C 2.5	8H 2.5	8H 2.4	3B 5.5	7H 5.5	2H 6.0			
		3G 2.5	2E 2.2	1G 5.5	3E 5.7	7C 6.4			

including A and D, negotiated a high enough interest rate in Period 7 to induce them to forgo the safety of their own projects. Interestingly enough, Lender F decided to go back to lending in Period 8, even as lending got riskier. Lender F also lent in Period 9, when lending became riskier yet. In contrast, Lender E stuck with their own project for the rest of the experiment. Similarly, D sought the safety of their own project from Period 8 on, and B did so in Period 9. Thus, in Period 9, with B, D, and E funding their own projects rather than lending to Borrowers 4, 6 and 7, projects with real returns of 1.0%, 1.5% and 1.5% displaced projects with real returns of 3.0%, 4.0% and 5.0%.

Period 5 was the one randomly selected to provide payoffs. All of the borrowers financed their projects that period, and with a perfectly predictable inflation rate, no one made any losses. So in addition to their stake of three pieces of chocolate, the borrowers each received payoffs from their projects, net of their financing cost. For instance, consider Borrower 5. Table 5 shows that they had a 3.5% real return on their project. They paid a nominal interest rate of 5.5%, which in real terms was 1.5%. The profit from their project was therefore 3.5% – 1.5% = 2.0%. Each 0.5% of profit generates one piece of chocolate, so Borrower 5 collected seven pieces. The person who lent to Borrower 5, Lender B, collected six pieces of chocolate, one for each 0.5% of real interest on the loan, plus the three from the stake. Altogether, this class collected 112 pieces of chocolate. When using the project values listed in Table 5, an instructor who brings to class an average of seven pieces of chocolate per student will have enough to provide the promised payouts, even for a Period such as 5, where the payouts were maximised because all of the highest-valued projects were financed.

Discussion

The next day in class, we spent 15 minutes on a follow-up discussion. To start the discussion, I asked the lenders to tell us the real returns on their projects. Then I asked the borrowers to do the same. The class noted that all of the borrowers had higher project returns than the lenders. We next observed that in the periods when the inflation rate was perfectly predictable, the credit market channelled all the funds to the highest-valued projects. Students remarked that as long as they could anticipate the inflation rate, whether 0% or 4%, they could factor it into their decisions, and arrange loans that made everyone better off. It's only after the inflation rate became variable that a nominal loan became risky and the credit market stopped working as effectively.

We considered how the events in Period 6, with its particularly high inflation rate, resembled the conditions in the United States that led to the Savings and Loan (S&L) crisis of the 1980s. These S&L banks suffered losses on their mortgage loans because of unexpectedly high inflation. The S&L losses constituted a wealth transfer to the homeowners who had borrowed from them at fixed nominal rates. Similarly, Period 3 resembled, on a small scale, the conditions that borrowers in the Great Depression faced when they lost their businesses, farms and homes due to unexpectedly low inflation. In this case, the borrowers' losses were the lenders' gains. Either way, the wealth transfer resulted from inflation uncertainty.

When asked to describe their decisions in the experiment, students reported that to avoid potential losses, lenders and borrowers both started asking for more favorable nominal interest rates on their loans. In fact, they could not always agree on a nominal interest rate that provided each enough compensation for their risk. So, some lenders took the safer course of using their funds for their own projects. Thus, the financing for some borrowers' projects dried up and we saw a social cost from inflation uncertainty, as the credit market no longer channelled funds to all the highest-valued projects.

Finally, we discussed how the experiment helps us understand why the Federal Reserve strives to maintain a predictable inflation rate. The Fed wants to prevent wealth transfers between borrowers and lenders that can have the devastating effects we saw during the Great Depression and the S&L crisis. Furthermore, the Fed wants to ensure that the credit markets can channel funds to the most productive investment projects, so that society enjoys growth in standards of living.

Six weeks after running the session whose results appear in Table 6, I put these students in pairs and asked them to take five minutes at the beginning of class to

describe what they learned from the inflation uncertainty experiment. Some of their responses to this open-ended writing assignment appear below.

- As range of potential inflation rates increased with each round, lenders were only willing to lend at higher and higher rates due to increase in risk.
- It is important to know or have a good idea about what future inflationary figures will look like in order to ensure profits from an investment. The inflation rate determines what group, borrowers or lenders, will profit most.
- The experiment showed how inflation affected borrowers and loaners differently, and how when inflation is unknown there are greater risks to both lending and borrowing. So this uncertainty in inflation led to lower confidence and less participation in borrowing and loaning.
- Lots of uncertainty sharply lowered the amount of loans, as more people invested in their own projects. It really showed how a high level of uncertainty was detrimental to investment. Low or high levels of inflation didn't seem to matter as long as it was predictable. The rate in itself had little or no effect.
- Inflation uncertainty certainly hampers investment. This is why the Fed is charged to keep inflation rates low and stable, since a low and stable rate makes investment decisions much easier.
- The higher inflation uncertainty is, the more difficult it is to get people to borrow or lend and make investments. So capital doesn't get allocated to best projects and people don't gain as much as they might have. This experiment really helped us to understand the inflation related concepts that we learned in class. It also showed the importance the Fed's job in controlling inflation has on the ability of our economy to maintain higher output.

When I use this experiment in my principles of economics course with an experimental component, I ask the following questions as part of a laboratory report assignment. To answer these questions, students need to know the returns on all the projects, as well as the experimental results. So, as part of the follow-up assignment, the instructor gives students the equivalent of Tables 5 and 6.

Laboratory report questions

1. Consider the periods when everyone knew there would be no inflation. Given the real interest rates on participants' projects, what does economic theory predict will be the nominal interest rate and quantity of loans? Explain, with reference to either the theoretical supply and demand curves for funds, or with reference to a supply and demand schedule. How closely did behavior in these periods match the behavior predicted by economic theory?
2. Consider the periods when everyone knew there would be an inflation rate of 4%. What does theory predict will be the nominal interest rate and quantity of loans? Explain how you found your answer. How close are the actual results to the theoretical predictions?
3. How did participants deal with inflation uncertainty when it was introduced in later periods? Did the nominal interest rates and quantity of loans change when inflation uncertainty was added, and as inflation uncertainty increased? How would you describe participants' attitudes toward the risk associated with inflation uncertainty? How would you describe the effects of inflation uncertainty on society in general? In particular, how would you say that inflation uncertainty affected investment in the projects?

Conclusions

This experiment provides concrete and memorable experience with the effects of anticipated and unanticipated inflation. What's more, the experiment is fun, with lenders calling out for the inflation-determining die to roll low, and borrowers doing victory dances when the die rolls high. After experiencing the wealth transfer produced by inflation uncertainty and seeing its effect on the credit market, students understand a central bank's goal of reducing inflation uncertainty. By demonstrating the importance of keeping inflation uncertainty low, the experiment provides the foundation for future class discussions of how central banks go about reducing inflation uncertainty, for instance by targetting inflation.

Appendix: Instructions for the inflation uncertainty classroom experiment

1. You are about to participate in an experiment involving borrowing and lending. The experiment will consist of a series of market periods. Each period you have the opportunity to invest in a productive project that earns the real interest rate shown on your information slip. Your project's real interest rate is the amount by which your purchasing power would increase if you invested in your project. Different people have projects that yield different real rates. Each project requires an investment of $100 and may only be undertaken once each period. Each project is completely over at the end of the period.
2. Your information slip tells you how much money you start each period with. Some of you start each period with $100. Those of you who have $100 have two options each period: (1) you may invest your $100 in your own project, or (2) you

may lend your $100 to someone else who will invest it in their project. The rest of you start each period with no funds, though you can finance your project by borrowing $100 from someone else. Regardless of what you do in a particular period, you will start the subsequent period with the funds (either $100 or zero) specified on your information slip, and nothing else. That is, each market period is completely separate from the others. Nothing you've done in the past carries over into the current period.

3. You may borrow or lend only once in each period, but you may also choose not to borrow or lend. Borrowers and lenders will contract for loans in terms of a nominal interest rate. The **nominal** interest rate specifies how many dollars will be repaid as a percentage of the $100 borrowed. The market institution is the double oral auction. Borrowers and lenders will mingle, calling out offers such as, 'I'll borrow at 2.6%,' or 'I'll lend at 8.75%'. All loans must be for exactly $100.

4. Once you have agreed upon a loan, come to the front of the room and report the interest rate and the IDs of the borrower and lender. I will post this information on the board for everyone to see. Once everyone who wishes to has entered into a contract, the loan market closes. After the loan market closes, you will find out what the inflation rate has been over that period. For the first few periods, there will be no inflation. In subsequent periods, I will roll a die to determine the inflation rate for that period. At the beginning of every period, I will announce whether there will be inflation that period and, if so, how the die roll will determine the inflation rate.

5. Your goal is to maximise your profits. Consider first those of you who start with $100 each period. If you lend, then your profits are the real interest rate you earned on the loan. You should lend only if you would earn a higher real interest rate from the loan than your project provides. Otherwise, you should invest in your own project, thereby earning profits equal to the real interest rate on your project.

6. Consider now those of you who start each period with no funds. If you borrow, then your profits are the real interest rate you earned on your project minus the real interest rate you paid for your loan. You should borrow only if your project provides a higher real interest rate than you would pay on your loan. Otherwise, you should do nothing, thereby earning profits of zero. Because you must contract in nominal terms, you will have to subtract the inflation rate from the nominal interest rate in order to calculate the real interest rate on your loan.

7. Please keep track of your actions on your record-keeping sheet. For each period, record your own ID letter or number in the borrower or lender column, depending on your actions that period. In the other column, record the ID of the person with whom you contracted. Record the nominal interest rate of your loan, the inflation rate, and the real interest rate on your loan. If you did not borrow or lend, leave all these spaces blank. Next, calculate and record your profits for that period. Note that you will record your profits in *one* of the last four columns, depending on what you did that period. Do not try to fill in more than one of the last four columns in each period.

8. You will collect your profits from the experiment in the form of chocolate. Everyone will start with three pieces. At the end of the experiment, I will roll a die to determine which one period will provide you with experimental profits. For each 0.5% profit that you earned that period, I will give you one additional piece of chocolate. If you earned a loss that period, then each 0.5% of your loss will reduce your chocolate by one piece.

Notes

* The author gratefully acknowledges Jeffrey Parker's help designing the inflation uncertainty experiment, and the funding provided by a grant from Will and Susanna Thomas and from the Sally Ann Abshire Research Scholar Award. She also thanks Noelwah Netusil for her helpful suggestions.

1 Note that the experiment does not ask students to record their economic profit. However, the instructor could choose to have students do so. The 'if you lent' column in the record-keeping sheet would then would have the real interest rate earned on the loan, minus the real interest rate on the student's project. Also, the student who funds his own project would have a profit equal to the interest rate on his project minus the opportunity cost of funds. The opportunity cost of the funds would be the real interest rate he could have earned, which is different every period. So, to make this profit calculation, we need to take the average of the real interest rates that period, and subtract this opportunity cost of funds from the real interest rate on the student's project. Similarly, those who did not borrow and have no funds would have a loss equal to the opportunity cost of their forgone profits (the real interest rate on their project minus the average real interest rate paid that period). The author understands that there are pedagogical benefits to this careful attention to measuring and recording opportunity cost. However, when she had students record economic profit, she found it made the experiment as a whole difficult enough for some students to understand that about one-third got confused and frustrated, and ended up behaving randomly. The author therefore simplified the profit recording so that students could focus on the main points of the experiment. Fortunately, whether students record their profits as economic or accounting does not affect their incentives.

References

Briault, Clive (1995) 'The Costs of Inflation', *Bank of England Quarterly Bulletin*, February, pp. 33–45.

Hess, Gregory D. and Morris, Charles L. (1996) 'The Long-Run Costs of Moderate Inflation', *Federal Reserve Bank of Kansas City Economic Review*, 81(2), 71–88.

Contact details

Professor Denise Hazlett
Department of Economics, Whitman College
345 Boyer Avenue, Walla Walla, WZ 99362
USA

Email: hazlett@whitman.edu