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ECONOMIC INSTRUCTION

A Goldsmith Exercise for Learning Money Creation

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In this article, the authors outline a classroom exercise involving goldsmiths designed to improve undergraduate students' understanding of how banks create money. This concept is important to macroeconomics and money and banking courses, yet students frequently struggle with it, largely due to the nonphysical nature of deposits and reserves. In contrast, gold-based banking systems tend to be more intuitive because of the physical nature of gold. By simulating interactions among a goldsmith, a depositor, a merchant, and a borrower in a gold-based system, students gain a deeper understanding of reserves and money creation. In particular, the exercise illuminates the intricate link between lending and the creation of new money, and highlights the importance of fractional reserve banking and reserve deposits.

Keywords *banking, classroom experiments, medium of exchange, money creation*

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In this article, we outline a classroom exercise involving goldsmiths designed to improve undergraduate students' understanding of how banks create money and the role of monetary policy in that process. These concepts are important components of many introductory macroeconomics and money and banking courses, yet students frequently struggle with them. One key reason is that in modern banking systems the money created by banks and reserves created by central banks are electronic. The lack of physical form makes money creation seem abstract and enhances the misconception that the process is arbitrary. In contrast, specie-based banking systems are rooted in a commodity—usually gold—whose physical aspects are well-known. By simulating money creation in a gold-based banking system, students gain a more intuitive understanding of money

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creation, the importance of the reserve ratio and total reserves to this process, and, by extension, the ability of central banks to effect changes in the money supply.

The exercise is inspired by several textbooks that introduce banks with a brief discussion of goldsmiths, who were the first bankers (e.g., Case, Fair, and Oster 2012; Cecchetti 2007). It builds on the insight that gold-based banking systems are more intuitive than fiat-based ones due to the physical nature of gold. In the exercise, students pretend they are in the eighteenth century and simulate interactions among a goldsmith, a gold depositor, a merchant, and a borrower. Through the interactions, students establish how paper notes linked to a commodity are created (gold notes), how those notes become a medium of exchange, and how, through the lending process, goldsmiths can create new money. They also see that money created in this manner can be linked to the purchase of a good or service and, therefore, to an increase in economic activity.[1]

Through the exercise, students also discover that goldsmiths' ability to make new loans and create new money depends on the backing ratio maintained by the goldsmith and the amount of gold deposits held by the goldsmith. In particular, students see that fractional reserve banking is necessary for money creation to occur. Students also discover that in order for goldsmiths to create more money while keeping the backing ratio the same, they must increase their holdings of gold reserves. After understanding that electronic reserves are similar to gold holdings and that central banks control both the backing ratio of bank liabilities and the level of electronic reserves, students can better understand the important role that modern central banks play in determining banks' ability to make new loans and create new money.

Finally, by asking students to create their own deposit and loan agreements, the exercise raises issues of adverse selection and moral hazard in credit markets and the mechanisms used in financial contracts to mitigate them. These topics can be explored in detail if the course and level of student preparation make it appropriate. It is not necessary to do so, however, for the main objectives of the exercise to be successful.

The exercise is designed for any undergraduate course that introduces banks and monetary policy, such as Introductory Macroeconomics or Money and Banking. It is similar to Laury's and Holt's (2000) classroom experiment in which students simulated interactions among depositors, borrowers, and a bank to demonstrate the impact of an increase in reserves on the total level of deposits. It is also like Cameron's (1997) classroom experiment in which students simulate interactions among a bank, borrowers, and firms to show the impact of expansionary open market operations. Our goldsmith exercise, however, attempts to remove an additional level of abstraction by simulating some of these interactions in a specie-based financial system. The exercise is also similar to Hazlett's (2003) classroom experiment in which students engaged in randomly matched bilateral trades ultimately settled on a generally accepted medium of exchange. Unlike Hazlett's experiment, however, the present one focuses exclusively on the role of banks in creating money and the intricate links among money creation, lending, and fractional reserve banking. As a result, unlike Laury and Holt (2000) and Cameron (1997), who used fiat money, and Hazlett (2003), who used commodity money, our exercise includes both commodity and representative paper money, defined as paper money backed by either an equal or lesser amount of specie. It therefore shows the first step in the evolution of payment systems beyond commodity money.

The article is based on experiences running the exercise in a liberal arts college with classes totaling between 20 and 35 students. It proceeds as follows. We first outline the necessary tools students should have for the exercise to be successful and the set-up of the exercise. We then

describe each of four stages of the exercise and the final discussion. Finally, we offer some possible extensions.

PRE-REQUISITES

A main goal of the exercise is for students to establish the counterpart of modern deposits, loans, and reserves in a specie-based system. Therefore, for the exercise to be successful, students must have familiarity with the following concepts: the functions of money, the evolution of payment systems (specifically why economies moved from using commodity money to using representative paper money), the basic functions of a bank, and a basic bank balance sheet. Without this background, it is difficult for students to discover the subtleties of the money creation process through the interactions modeled here. In particular, it is important that students track a goldsmith's transactions in a balance sheet. This usually necessitates experience outlining modern bank transactions in a balance sheet. It is not necessary, however, for students to have familiarity with central banks or the tools of monetary policy. Indeed, this exercise provides a logical lead into these topics.

THE SET-UP

The exercise takes a full class period and requires the materials described below.[2] The number of students must be sufficiently small so that they can form groups of four, engage in various interactions within the group, and discuss the outcomes with the entire class. If the number of students is not divisible by four, the instructor can allow for groups of five that include more than one merchant.

To start the exercise, students form groups of four in whatever way the instructor deems optimal.[3] Each group is given the items described below. We have developed examples of all of these items, particularly the student record sheets, which incorporate many of the questions we suggest instructors ask during this exercise. These examples are available on the Web sites of both authors.

(1) Four individual record sheets, one for each group member. Each sheet should have blank balance sheets and space to answer specific questions that will be asked during the different stages of the exercise. Each student must fill out his or her own record sheet and turn it in to the instructor at the end of the exercise. The record sheets should require students to track not only their own financial position, but also the positions of the other group members. This encourages collaboration among the members and ensures that students are involved in every stage of the exercise, even if they are not directly engaging in a transaction.

(2) Initial endowments of gold coins for the Depositors. These vary across groups and assume one of three values: \$100, \$150, and \$200.[4] Heterogeneity in Depositor endowments creates differences in the backing ratio for the representative paper money issued by different Goldsmiths. This helps highlight the importance of fractional reserve banking in the money creation process, a point that is emphasized throughout the exercise. It

also introduces an information asymmetry, because students know neither how much gold Depositors in other groups have, nor the backing ratio of other Goldsmiths. These differences are useful in detailing the conditions under which gold notes issued by different Goldsmiths will be accepted.

(3) A blank transaction certificate. Groups are told that they will be instructed in how to use the certificate and that more certificates are available if needed.

(4) Something tangible, such as a certificate, which Merchants can use to provide a physical representation of their goods.

(5) A sheet describing the role of each player, as listed below.

After students form groups and receive their materials, the instructor reads the following instructions:

"You are all back in the 1700s. Your group consists of four players:

(1) *A Goldsmith.* The Goldsmith accepts deposits of gold coins and can also make loans. The Goldsmith is well established and trustworthy (i.e., this is not a Goldsmith who just started business). The main costs of storing gold involve security, as this is necessary to limit the chance that gold deposits are stolen. To prevent theft, the Goldsmith has invested significantly in security, such as a safe vault and guards. Because the Goldsmith deals with more gold coins than any individual Depositor, the Goldsmith has invested more in security than any individual Depositor and therefore faces a much lower risk of robbery.

(2) *A Gold Depositor.* The Depositor is a wealthy individual with a quantity of gold coins equal to the endowment they are given. The risk of robbery is zero if the gold is stored with a Goldsmith but significantly higher than zero if the gold is stored at home. Also, given the size of the Goldsmith, the security costs per gold coin are lower for the Goldsmith than for you. Warning: There is a 50-percent chance that any gold carried outside of your group will be stolen from you![5] Note that different Depositors may have different endowments.

(3) *A Borrower.* The Borrower is an individual who expects to receive an endowment of gold in the future (at the end of the exercise). This endowment will be equal to that of the gold Depositor in your group.

(4) *A Merchant.* This is an individual selling a good or service that would be appropriate in the eighteenth century. Every Merchant has four units of a good and must charge $50 for each unit of whatever good they decide to sell.

Each member of your group must choose a different role. Write down your role and the names and roles of your other group members on your record sheet. This record sheet will be used to document various transactions that will take place. You will have to answer specific questions and keep track of the financial position of all members of your group. At the end of the exercise, I will collect your record sheets and assess their accuracy. To start, record your answers to the following questions on your record sheet:

(1) List one thing that makes the Goldsmith in your group good at security.

(2) What role (in the 1700s) does the Depositor in your group have? Why might they be interested in depositing gold coins with the Goldsmith?

(3) What role (in the 1700s) does the Borrower in your group have?

(4) What good or service is the Merchant in your group selling?

(5) Merchants: Will you accept gold coins as payment for your products? Why or why not?"

After choosing roles and answering the questions, students report their identities to the class and the instructor writes them down in a way that can be easily referenced during the exercise (on the board, for example). This reporting accomplishes several goals. First, it reveals and allows for correction of any misconceptions students may have about the setup and the roles of the players. For example, it becomes obvious that students are not seriously thinking about a gold-based banking system if Merchants choose modern goods and services like cars or computer services. It also becomes obvious that students do not understand that the Goldsmith is functioning like a bank if they talk about wanting the Goldsmith to melt down gold coins and turn them into other objects.

Second, listing the goods and services sold by the Merchants helps establish the class as an economy in which multiple products are for sale. During the exercise, students are required to buy products from other groups and must refer to the list to decide which Merchants they want to visit. Third, because almost all Merchants say they will accept gold coins, this confirms that gold coins function as a medium of exchange.

Finally, the assumption and declaration of identities helps students to become more serious about the exercise and to think more deeply about their interactions with the other players. The last question in particular encourages them to begin grappling with the practical issues raised in this exercise.

Students next are asked to write down the initial balance sheets for every member of the group on their record sheet. In our experience, the exercise is more successful if students understand the concept of a balance sheet and if they keep track of the balance sheets for all group members, not just themselves. We tried running the exercise without balance sheets, instead asking students to list their assets and liabilities, but found that this led to a high level of confusion. For example, several groups thought the provision of security was a liability of the Goldsmith. We found that for students to understand how the Goldsmiths in the exercise create money, they must understand balance sheets. Students within each group should work together on this task, and instructors should review the balance sheets of the different groups to ensure they are correct. If an instructor has not yet covered balance sheets in their course, we encourage them to take some time to do so before running this exercise. The exercise will then serve as a good way to solidify student understanding of balance sheets.

For a group with a Depositor endowment of $150 of gold coins, the initial balance sheets look as follows:

Goldsmith		**Depositor**	
Assets	Liabilities + Equity	Assets	Liabilities + Equity
$0 assets	$0 equity	$150 gold	$150 equity
Merchant		**Borrower**	
Assets	Liabilities + Equity	Assets	Liabilities + Equity
$200 goods	$200 equity	$0 assets	$0 equity

Students now are asked to record their answers to questions that highlight the fact that gold coins function as a medium of exchange and that prior to the existence of banks, purchasing power was determined by the volume of commodity money. These questions are

(1) What is your purchasing power? That is, how many goods and/or services could you purchase?
(2) How much purchasing power in total is there in your group?

After giving students a minute to answer these questions, the instructor asks, "Does the total purchasing power of your group equal the amount of gold coins within your group?" Every group should answer yes. If they do not, ask why not. Some groups may respond that their purchasing power is higher because the Merchants can use their goods to purchase other goods. In other words, if the students are thinking about barter, they will list their purchasing power as greater than the amount of money they have. For the remaining stages of the exercise to be successful, it is necessary to eliminate barter as a possibility. If students do list the Merchants' goods as a form of purchasing power, ask them if the Merchant is sure she could buy any other good or service with her product. Would they, in turn, be willing to accept another good as payment for their wares instead of money? After thinking about these questions, students usually realize that money is a more effective medium of exchange and discard barter as an option.

INTERACTIONS

Groups now engage in four rounds of interactions. Each round begins with the instructor reading a set of instructions.[6] Group members who do not have a particular task during an interaction are encouraged to provide counsel to those who do so that everyone participates in all stages of the exercise. After each interaction, the instructor asks specific questions (detailed below). At certain points, the instructor asks groups to report their answers to the class and follows these reports with a discussion. Given the complexity of some of the concepts, we have found that students do not make all the links on their own and that discussions are necessary after each interaction to formalize and solidify the results.

The First Interaction: Depositor and Goldsmith

To begin this round, the instructor reads the following to the class:

> "Depositors, you must deposit your gold coins with the Goldsmith. Both the Depositor and the Goldsmith must agree on how this transaction will be documented. For example, as a Depositor, are you willing to leave the Goldsmith's office with a simple handshake? If not, you can use the blank certificate(s) to write down the terms of your agreement with the Goldsmith. More certificates are available if you need them, and both the Goldsmith and Depositor can mutually agree to change the certificate(s) during the exercise."

The goal of the first interaction is to describe the creation of representative paper notes that are 100 percent backed by gold. Groups naturally come up with some form of IOU or deposit slip, as no Depositor is content with a handshake and instead wants physical evidence of the Goldsmith's obligation. Students often write very specific contracts that include the name of the Goldsmith, the Depositor, and the exact terms. For example, "Goldsmith Bob owes Depositor Sarah $150 upon presentation of this note. If Goldsmith Bob absconds with the gold, Depositor Sarah has the right to take his horse." The details of the IOUs vary, and the exact form is not important because students will be able to modify them as the exercise progresses.[7]

After giving students a few minutes to work out the Depositor/Goldsmith agreement, the instructor begins a follow-up discussion that expounds on the details of the IOUs and their implications. The objective is to introduce the concept of a bearer note, or an IOU that is payable to anyone who holds the note (the bearer) rather than to a specific person. The idea of a bearer note is important, because while students usually understand the impetus to create representative paper money, they frequently have not discussed the exact form this money takes. Bearer notes function more easily as a medium of exchange than individual notes, and thus for these IOUs to function as money, they must be general.

The need for a bearer note over an individual IOU is illuminated by asking Depositors the following: "Suppose you want to pay for something that costs $50. How would you go about doing this?" The instructor can call on individual groups to answer. Students usually say something about taking their IOU to the Goldsmith's office, withdrawing the coins, and then walking to the Merchant. It is then appropriate to ask, "Is there an easier way to do this?" Depositors often see that if their IOU is made more general, they can eliminate the intermediate step of going to the Goldsmith, instead giving an IOU directly to the Merchant. The instructor then asks students to discuss the benefits of a bearer note over the IOUs they have constructed (in our experience, almost no group comes up with a bearer note on their own) and asks Depositors if they would prefer a bearer note over a person-specific IOU. In most cases, Depositors switch to a bearer note, and the new versions of these notes tend to look quite similar. At this point, however, the concept of a bearer note may remain vague for some groups. Their role and benefits will become more apparent when Depositors start purchasing in the next round.

The instructor now explains to the groups that the IOUs from the Goldsmith are called gold notes, and they represent claims on the gold held by the Goldsmith. This leads to the second objective of the follow-up discussion, which is to establish these gold notes as liabilities of the Goldsmith. It is helpful to frame gold notes in language similar to that used to describe demand deposits (this is where an earlier discussion of modern banks is helpful). For example, the instructor should specify that gold notes allow the holder to withdraw the amount of gold specified on the note from the Goldsmith at any point in time. If students have previous exposure to a basic bank balance sheet, they can also see that similar to demand deposits, gold notes represent a liability to the issuing institution.

This intuition is cemented by asking groups to detail the transaction in the balance sheets. Continuing the example of the group above (with a $150 endowment), the balance sheets now look as follows:

Goldsmith		**Depositor**	
Assets	Liabilities + Equity	Assets	Liabilities + Equity
$150 gold	$150 gold notes	$150 gold notes	$150 equity
Merchant		**Borrower**	
Assets	Liabilities + Equity	Assets	Liabilities + Equity
$200 goods	$200 equity	$0 assets	$0 equity

At this point, the instructor should look at groups' balance sheets to make sure they recognize that the gold note(s) is an IOU for the Goldsmith and therefore appears as a liability. Students must see the gold note(s) as a thing the Goldsmith *owes* and are explicitly asked to keep track of these liabilities on the record sheet. This has an additional benefit if the class later discusses

a central bank's balance sheet, as it helps reduce confusion over the fact that currency is one of the main liabilities of the central bank. After this exercise, students tend to be more comfortable with the idea that paper money is a liability of the issuing institution, even if its current form is fiat rather than representative money.

Students also should recognize that the gold note(s) is an asset to the Depositor and that through this transaction Depositors have exchanged a real asset for a financial one. This also is the appropriate place to discuss what portion of a loan agreement appears on the balance sheet, principally the fact that interest or collateral are not counted as liabilities. Frequently, students write the Goldsmith's liability as the principal plus any interest they have agreed to pay the Depositor. This is the right time to rectify this misconception.

The final step in this interaction is to show that at this time, the gold notes are 100 percent backed by gold deposited with a Goldsmith. This is achieved by asking students to write down on their record sheets the value of gold deposits held by the Goldsmith in their group divided by the value of the gold notes issued by their Goldsmith. The instructor can highlight that a 100-percent backing ratio means the Goldsmith is able to redeem all of the gold notes he/she has issued whenever the holders of these notes ask to exchange them for gold. The point is made later that in order for money creation to happen, the backing ratio must fall below 100 percent.

The Second Interaction: Depositor and Merchant

To start the second interaction, the instructor reads the following instructions:

> "Depositors, you must buy one good from a Merchant in another group. You offer to pay the Merchant using the gold notes you just received. Merchants, you must decide if you are willing to accept the gold notes or not. You also must explain why you would be willing to accept the gold notes or not. Are there some cases when you would be willing to accept the gold notes and some cases when you would not? Under what conditions might you not accept them? There are more certificates available if you need them."[8]

The main goal of the second interaction is to illustrate that when a sufficient number of Merchants accept gold notes, they function as a generally accepted medium of exchange. This demonstrates the first step in the evolution of payment systems, as the economy evolves from relying exclusively on commodity money to relying on a combination of commodity and representative paper money. Initially, the transactions tend to be awkward because Depositors typically received a single slip for their entire deposit, yet want to spend only part of it. At this point, many groups decide to rewrite their deposit slips. For example, some Depositors may ask for multiple deposit slips, each in $50 increments, which they use instead of one slip for the entire amount of gold deposited. Some Depositors may tear off a piece of the original contract and sign it over to the Merchant, while other Depositors may simply replace their name with the Merchant's on one of the contracts, effectively signing off a portion of the IOU to another party.[9] This interaction further highlights the impetus for generalized IOUs, or bearer notes.

After the transaction, the instructor asks each Merchant to report the form of payment they accepted to the entire class. In our experience, a large majority of Merchants choose to accept the gold notes as payment. Assuming they do, the instructor points out that gold notes are functioning as a medium of exchange. The acceptance of gold notes is due partially to an earlier discussion of the transportation and storage costs of gold and the reasons why economies evolved beyond

commodity money. Nevertheless, some Depositors may be tempted to pay with gold, in which case it is necessary to enforce the threat of theft. This can be achieved through a coin toss, in which either heads or tails results in a loss of gold. In some cases, Merchants have stipulations for accepting the notes, such as that the issuing Goldsmiths are well-known or trustworthy. This provides an opportunity to discuss the problems of adverse selection in financial contracts, if appropriate for the course. If the concerns over adverse selection are severe enough, it might be necessary to introduce an assumption that all Goldsmiths are trustworthy.

Following the interaction, all students are asked to update their balance sheets. The instructor should walk around to groups to ensure the updates are correct. If Merchants accept gold notes as payment for the goods, the balance sheets for our example group look as follows:

Goldsmith		**Depositor**	
Assets	Liabilities + Equity	Assets	Liabilities + Equity
\$150 gold	\$150 gold notes	\$100 gold notes **\$50 good**	\$150 equity
Merchant		**Borrower**	
Assets	Liabilities + Equity	Assets	Liabilities + Equity
\$150 goods **\$50 gold notes**	\$200 equity	\$0 assets	\$0 equity

The instructor now asks several questions to make explicit the point that while the Goldsmiths have created a new *form* of money, they have not created any new money.

(1) How many goods or services could the Depositor have purchased before depositing his/her gold? In other words, how much purchasing power did the Depositor have? *Answer:* \$150 (refer to answer from set-up).
(2) How many goods and services could the Depositor have purchased with the gold notes right after depositing the gold? In other words, how much purchasing power did the Depositor have after depositing gold and taking away gold notes? *Answer:* \$150.
(3) Did depositing gold change the Depositor's purchasing power? *Answer:* No.

The instructor now specifies that gold notes represent a claim on gold and are deemed sufficiently valuable that they are accepted as payment for goods and services. As a result, no new money has been created, but neither has money been lost.[10] The Depositor has the same purchasing power regardless of the form. For new money to be created, lending must occur. This happens in the third interaction. Finally, it is useful to highlight that the backing ratio of the gold notes has not changed due to this transaction, and it remains at 100 percent. The Goldsmith retains the ability to exchange all outstanding gold notes for gold at any point in time.

The Third Interaction: Borrower and Goldsmith

The instructor begins this round by reading the following to the class:

> "Good news for Borrowers: At the end of the exercise, you will receive an endowment of gold coins equal to that of the Depositor in your group. Unfortunately, you need to make a purchase before then. Borrowers, in this round you must find a way to work with the Goldsmith in your group to finance your impending purchase. Recall that you must leave the Goldsmith's office with a medium

of exchange, a means of purchasing a good. There are two options for a medium of exchange: gold coins and gold notes. Other group members should help you work this out. When you are done, update the balance sheets on your record sheet."

The main goal of this interaction is to illustrate the process of money creation and the link to fractional reserve banking. Most Borrowers agree to accept gold notes, particularly after the class establishes that they function as a medium of exchange. However, if many Borrowers take gold coins rather than notes it might be necessary to highlight the 50-percent probability that coins are stolen in transit. Each Borrower should report their choice of a medium of exchange to the entire class. The details of the loan with respect to interest rates, restrictive covenants, collateral requirements, and repayment schedules tend to vary across groups, and students are asked to write the details down on their record sheets. The reasons for these differences naturally raise the issues of adverse selection and moral hazard in loan contracts, in addition to the mechanisms lenders use to combat each of these problems. Depending on the course and the background of the students, the instructor can choose to emphasize these points or not. An elaboration of the topic of asymmetric information in lending, however, is not necessary to achieve the main goals of the exercise.

The instructor should look at groups' balance sheets to make sure they are correct. The balance sheets for our example group now look as follows:

Goldsmith		**Depositor**	
Assets	Liabilities + Equity	Assets	Liabilities + Equity
\$150 gold	\$150 gold notes	\$100 gold notes	\$150 equity
\$50 new loan	**\$50 new gold notes**	\$50 good	
Merchant		**Borrower**	
Assets	Liabilities + Equity	Assets	Liabilities + Equity
\$150 goods	\$200 equity	**\$50 gold notes**	**\$50 loan**
\$50 gold notes			

The balance sheets illustrate that the Borrower's (and, therefore, the entire group's) purchasing power has increased due to the loan and the related creation of new gold notes. In some cases, it might be necessary for the instructor to highlight that a new loan is complemented by a new bank liability; in other words, to clarify that a loan transaction appears on both sides of a bank's balance sheet. Sometimes students are confused by this fact, not understanding how the loan represents an asset to the bank but also generates a liability. To reduce this confusion, it helps to impress that the Borrower must leave the bank with a medium of exchange and that this medium of exchange did not exist before the Goldsmith created it.[11]

The first objective of the discussion is to establish that the new gold notes created for the Borrower represent new money. To emphasize this point, the instructor asks students to record their answers to the following series of questions on their record sheet:

(1) How much purchasing power does the Depositor have?
Answer: \$100
(2) How much purchasing power does the Borrower have?
Answer: \$50

(3) How much purchasing power does the Merchant have?
Answer: $50
(4) What is the total purchasing power in your four-person economy?
Answer: $200
(5) What is the amount of new money that has been created?
Answer: $50

The second objective of the discussion is to show that money creation and lending require the Goldsmith to reduce his or her backing ratio. The balance sheets illustrate that the gold notes issued by the Goldsmith are no longer 100 percent backed by gold deposits. To re-enforce this point, the instructor asks students to determine the new backing ratio for the gold notes on their record sheets. In our example group, the backing ratio falls from 100 percent to 75 percent. For the groups with initial Depositor endowments of $100 and $200, the backing ratios fall to 67 percent and 80 percent, respectively. To ensure students understand the implications of reduced backing, the instructor asks each group, "Does your Goldsmith have enough gold to redeem all of the gold notes he/she has issued?" Students immediately see that the Goldsmith does not have this capacity.

At this point, some Depositors and Merchants may become concerned about the value of the gold notes they hold and the reliability of the Goldsmith who issued them. To explore these concerns, the instructor asks, "Under what circumstances would an individual note holder seek to exchange *all* of his/her notes for gold?" Most groups indicate that these circumstances are rare because the notes function as a medium of exchange as long as Merchants will accept them.

The instructor then asks, "What is the chance that *all* note holders—Depositors, Merchants, and Borrowers—decide to exchange *all* of their gold notes for gold at the same time?" The instructor next explains that if this very rare event occurs, it is called a bank run. Because banks have a backing ratio below 100 percent, they never have sufficient funds to redeem all outstanding notes simultaneously. However, because bank runs are extremely rare, banks can operate with a backing ratio below 100 percent for the money they create.

Once it is established that banks can issue money that is not completely backed by gold, the instructor asks about the appropriate level of backing. The instructor states, "Depositors, Merchants, and Borrowers, all of you hold gold notes. Is there a backing ratio below which you would be unwilling to hold the notes, instead preferring gold coins despite the higher transport costs and heightened risk of theft? What factors did you consider when determining this level?" The values may vary across groups, but many groups recognize that the appropriate backing ratio is linked to the likelihood of redemptions. If redemptions are expected to be high, the backing ratio should be high. If redemptions are expected to be low, the Goldsmith can maintain a lower backing ratio and issue larger amounts of gold notes.

The Fourth Interaction: Borrower and Merchant

To begin this round, the instructor reads the following to the class:

> "Borrowers, you must buy one good from a Merchant outside of your group. Depositors, you may also buy another good if you choose, but you are not required to. After you have finished these transactions, return to your group and update each group member's balance sheet on your record sheets."

The instructor should walk around to groups and ensure the updates are correct. The balance sheets for our example group look as follows:

Goldsmith		**Depositor**	
Assets	Liabilities + Equity	Assets	Liabilities + Equity
\$150 gold	\$150 gold notes	\$100 gold notes	\$150 equity
\$50 new loan	\$50 gold notes	\$50 good	
Merchant		**Borrower**	
Assets	Liabilities + Equity	Assets	Liabilities + Equity
\$100 goods	\$200 equity	**\$50 good**	\$50 loan
\$50 gold notes			
\$50 new gold notes			

The goal of this interaction is to complete the process started when the Borrower was told he/she needed to borrow money for a future purchase. This interaction is not absolutely necessary to demonstrate the main points of the exercise, and instructors with limited time can eliminate it. The final round of buying, however, can serve to put additional gold notes in the Merchant's hands and offers an additional opportunity to evaluate the effects of fractional reserve banking.

Final Debriefing and Discussion

The final part of the exercise is a debriefing and discussion to help cement the understanding of how each interaction relates to money creation. Although several of these questions have been asked previously, we have found it useful to ask them again here to highlight the main points of the exercise. The instructor asks the following:

(1) How much purchasing power was there at the beginning of the exercise?
Answer: The sum of gold coins for all Depositors.

(2) How much purchasing power was there after Round 1?
Answer: The same as part #1. Depositors have the same amount of purchasing power. They simply have gold notes instead of gold coins to pay for goods. This illustrates that Round 1 of the exercise involves the creation of a new form of money, specifically representative paper currency, but does not lead to any new money creation. Purchasing power did not increase in Round 1.

(3) How much purchasing power is there at the end of the exercise?
Answer: The sum of all gold notes outstanding, which equals the initial gold endowments plus the new loan. This clearly illustrates that money creation is linked to lending.

(4) How many gold notes did the Goldsmith issue?
Answer: The sum of the gold deposit and the loan.

(5) What happened to the backing ratio of the gold notes as a result of the loan?
Answer: It fell below 100 percent. The new backing ratio varies across groups and depends on the groups' initial gold endowment.

The instructor next guides students through a discussion that illustrates the importance of gold deposits and fractional reserve banking to the lending and money creation process. Once students understand that these are critical to Goldsmiths' ability to make new loans and create new money,

they can make the transition to modern banking and the tools central banks use to change the money supply.

The debriefing begins by focusing on the concept of fractional reserve banking and the influence central banks have on this through reserve requirements. The instructor says, "Suppose there is a central authority that can regulate Goldsmiths. This authority declares that the backing ratio of gold notes cannot fall below 60 percent. If a second Borrower seeks to borrow $50 from the Goldsmith in your group, will the Goldsmith be able to make the loan?" The answer depends on the amount of gold within the group. In groups with an initial endowment of $100, the Goldsmith cannot make the loan because the backing ratio will fall to 50 percent. In groups with initial endowments of $150 and $200, the Goldsmiths can make the loan, as the backing ratio will fall to 60 percent and 67 percent, respectively. The case of groups with initial endowments of $150 is illustrated below. If the Goldsmith makes the new loan, $150 in gold will support $250 in gold notes.

Goldsmith

Assets	Liabilities + Equity
$150 gold	$150 gold notes
$50 existing loan	$50 gold notes
$50 new loan	**$50 new gold notes**

The instructor now asks, "What if the regulator lowered the backing ratio to 50 percent, will the Goldsmith in your group be able to make a $50 loan?" Now all groups will be able to make the loan, meaning even more new money can be created than could be when the required backing ratio was 60 percent. The instructor can explain that this mandated backing ratio is called a reserve requirement and is a tool used by central banks to increase or decrease banks' ability to make new loans and create new money.

Another important piece of monetary policy is changing the overall level of reserves in the banking system. In the gold-backed system, this is equivalent to the arrival of new gold into the economy, perhaps due to the discovery of new gold deposits. The instructor states, "A new Depositor arrives in your four-person economy and deposits $100 in gold coins with the Goldsmith. He/she receives $100 in gold notes in exchange. How many gold notes are now outstanding? What is the backing ratio? Assume the second $50 loan was made (building off of the previous example)." In our example group, the new Goldsmith balance sheet looks as follows:

Goldsmith

Assets	Liabilities + Equity
$150 initial gold	$150 gold notes
$100 loans	$100 gold notes
$100 new gold	**$100 new gold notes**

Now, $250 in gold deposits backs $350 in gold notes, causing the backing ratio to rise from 60 percent to 71 percent. For the other two groups, it rises to 67 percent and 75 percent, respectively. This clearly shows that with more gold, the Goldsmith can make more loans and create more money without the regulator changing the required backing ratio. In other words, expanding the monetary base can allow banks to increase loans.

To make the point more general, the instructor asks, "What increases the Goldsmith's ability to make more loans and create more money without lowering the backing ratio?" At this point, all of the groups should answer that this ability is determined by the amount of gold held by the Goldsmith. Students see that the ability of the Goldsmith to write liabilities with minimal risk of default—and therefore the ability to make more loans and create more gold notes—depends on how much gold he/she has in the vault.

To link the importance of reserves to modern banks, the instructor asks, "What determines a modern bank's ability to make loans and create new money?" The answer to this is the reserve ratio and the quantity of reserves, which groups may or may not come up with on their own. Either way, the instructor emphasizes that with more reserves banks can make more loans for a given reserve requirement. With fewer reserves, banks cannot make as many loans with a given reserve requirement. In modern banks, cash reserves serve a function similar to gold deposits in the economy of this exercise. Now that students understand the importance of gold reserves, the importance of electronic reserves is also clearer.

An appreciation of the importance of reserves to the lending process helps students understand the role that central banks play in the money creation process. In particular, students can comprehend better the idea that by controlling the backing ratio and level of reserves in the banking system, central banks can heavily influence the amount of loans and new money that banks can create. In our experience, after participating in this exercise, students have a more intuitive understanding of the role central banks play in influencing the money supply in an economy.

POSSIBLE EXTENSIONS

We offer two possible extensions for this exercise. The first introduces the possibility of loan default and the potential implications for bank insolvency. Loan default does not arise automatically in the exercise because of the assumption that the Borrower's future income is guaranteed and so loan repayment assured. These assumptions can be modified, however, by making the Borrower's future endowment uncertain. An easy way to do this is by flipping a coin, having "heads" result in the Borrower receiving their full future endowment and "tails" result in the Borrower receiving none of their future endowment. If the Borrower's future endowment does not materialize, she must default on her loan. This results in a decline in the Goldsmith's assets, although liabilities remain the same. Because the Goldsmith does not have equity, liabilities now exceed assets and the Goldsmith becomes insolvent. In other words, the Goldsmith no longer has sufficient assets to pay back all of the liabilities. The presence of equity, also called bank capital, could allow Goldsmiths to absorb loan losses without becoming insolvent. This extension demonstrates how banks could become insolvent and the role that bank capital plays in preventing insolvency. This extension can be used to begin more detailed discussions of the sources of risk to bank solvency, the importance of bank capital in managing these risks, and the implications of bank insolvency for depositors.

A second possible extension would make use of the asymmetry in Depositor endowments and the subsequent asymmetry across Goldsmiths in their backing ratios.[12] The instructor can ask students to consider what will happen to the backing ratio of the Goldsmith in their group if the Depositor withdraws some of their gold. For example, suppose the Depositor in our sample group withdraws $50 of his/her gold deposits. Based on the balance sheets for our example group

at the end of the exercise (without the debriefing), the withdrawal means gold notes issued by this Goldsmith go from a backing ratio of 75 percent ($150 in gold for $200 in gold notes) to a backing ratio of 67 percent ($100 in gold for $150 in gold notes).[13]

The instructor now informs the class that the notes issued by different Goldsmiths have different backing ratios: some higher and some lower than others. The instructor asks the students how this might influence their view of the different notes. Most students are at first uncertain about how to respond to this news, understanding that a higher backing ratio is better for them, but not sure how much to be concerned when a Goldsmith's backing ratio declines. The instructor can next point out that another withdrawal of $50 would eliminate the rest of the gold deposits held by at least one Goldsmith (those who started with $100 in gold deposits) even though that Goldsmith would still have gold notes outstanding. The instructor can ask students what they would do if they knew they were holding notes issued by a Goldsmith who was close to running out of gold to back their notes. Some students will ask which Goldsmiths have such low backing ratios, some with the idea that they will no longer accept notes from these Goldsmiths and others thinking they will seek to redeem any notes they currently hold that were issued by these Goldsmiths. Both of these ideas lead to similar conclusions: Notes issued by Goldsmiths with low backing ratios are not as safe as notes issued by goldsmiths with high backing ratios. The lack of information about the backing ratios of different Goldsmiths may lead students to question the value of all gold notes issued by other Goldsmiths. This extension can be used to introduce several different topics related to the importance of maintaining confidence in the integrity of bank notes, including the problems of asymmetric information with regard to bank liquidity and solvency, how these problems can lead to bank runs (even for well-backed gold notes), and the importance of deposit insurance in improving depositor confidence and reducing the incidence of bank runs.

CONCLUSION

In this article, we describe a classroom exercise involving goldsmiths designed to improve undergraduate students' understanding of how banks create money. It is built on the premise that gold-based banking systems are more intuitive than fiat-based ones due to the physical nature of gold. By playing out the interactions among a Goldsmith, a Depositor, a Borrower, and a Merchant, students participate in the money creation process in a specie-based system. In our experience, running the exercise in introductory macroeconomics and money and banking classes at a liberal arts college, the exercise deepens students' intuition about money creation and enhances their understanding of the role that fractional reserve banking and reserves themselves play in the money creation process.

NOTES

1. We believe that working through a hands-on exercise about the very early stages of money creation enables students to develop a deeper understanding of the modern process than they would obtain from simply discussing electronic reserves and fiat money. Studies show that actively engaging students in the learning process increases the depth and duration of learning. See Yamarik (2007) for a specific example and Miller and Rebelein (2012) for a survey of literature on this issue.

2. Our class periods were 75 minutes. The time required could be reduced by eliminating the fourth interaction or by postponing the debriefing after the interactions to a subsequent class period.
3. See Barkley, Cross and, Major (2005) for a discussion of the pros and cons of different methods of forming groups. We chose to assign students to groups by having them count off up to the number of groups to be formed.
4. We found it helpful if the initial endowments have a physical form, such as candy, balloons (inflated), a small bag of rocks, or some other bulky, heavy, or hard-to-carry items. This reinforces the high transportation cost of gold and makes it more interesting to see if the willingness to accept gold notes increases when students have to leave their group and the transportation costs increase. We find that using physical money, such as Hershey's kisses, where one piece equals one $50 gold coin, emphasizes the drawbacks of commodity money and the benefits of using representative paper money.
5. We found that a tangible threat of loss of their gold is important to discourage students from using gold to make purchases. We chose this high probability of theft to encourage Depositors to deposit their gold and because it easily can be enforced with a coin toss.
6. The instructions presented in this section are summarized on a single sheet in an Appendix A, available on each author's Web site.
7. For example, Depositors differ in their desire to receive interest from the Goldsmith, the term of the deposit, the inclusion of restrictive covenants (the Goldsmith cannot melt down the gold, for example), and the inclusion of channels for recourse if the Goldsmith cannot pay the Depositor back the coins. Some instructors may prefer to use the term "deposit slip" rather than IOU to indicate the fact that the Depositor has deposited his or her gold with the Goldsmith. We find using the term IOU better conveys to students the fact that the Goldsmith has incurred a liability in the deposit transaction.
8. The Depositor could be instructed to buy something from the Merchant in his or her group. However, having the notes issued by a Goldsmith circulate outside the Goldsmith's group is necessary in later stages of the exercise (and in the extensions) in order to generate uncertainty about the backing ratio behind notes issued by different Goldsmiths.
9. Sometimes, students try to use new IOUs to create a claim by the Merchant on the assets of the Depositor. Such practices should be discouraged by pointing out that the trustworthiness of the Depositor is unknown, and he or she may or may not be able to make good on this debt in the future. In contrast, the Goldsmiths are more trustworthy because they have a reputation to protect.
10. We assume no discounting of the gold notes takes place.
11. Students may raise the possibility of scrip, in which the Borrower uses the loan agreement to purchase goods and services. Usually, however, asking Merchants if they are willing to accept this over either gold coins or gold notes, which have been established as a medium of exchange, eliminates scrip as an option.
12. Note that this extension does not build on the first one, so instructors wishing to use this extension should remind students to return to the situation without loan default.
13. Alternatively, the instructor could have the Goldsmith make additional loans. We prefer having the Depositor withdraw his or her deposits because that leads to more substantial declines in the backing ratio.

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