

The Simple Economics of Bank Runs

by Kevin Hasker

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Never underestimate the capacity of the Eurozone to shoot itself in both feet.

"Breath-taking," "Staggering," "Bewildering." Just some of the adjectives we could use to describe the latest Eurozone fiasco where the troika – made up of the European Commission, the European Central Bank and the International Monetary Fund – has managed to snatch defeat from the jaws of victory.

—Richard Quest, CNN International Business Correspondent¹

The word "disastrous" springs readily to mind. Someone forgot to mention to the Euro Group that monetary unions, when they die, die because of bank runs, and bank runs happen when people have no confidence that they're going to get their money back.

—Paul Donovan, Managing Director, Global Economics, UBS²

The Eurozone leadership has offered a 10 billion euro bailout to Greek Cyprus on the terms that they raise about 7 billion euro themselves. How should they raise this money? They should take (levy) about 10% of the savings in the country. In other words, if you have 100 thousand Euros in a Greek bank they will take about 10 thousand. Let me mention that the average price of a house in Nicosia, Cyprus is around than 500 thousand euros, so this is less than a fifth of the money you would need to buy a house. The bailout, like most bailouts these days, was because of the banks. Banks lent around 160% of the country's GDP to Greeks.³ Most of this was in Greek government bonds. When the Eurozone bailed out Greece they forced investors to accept a "soft default" on Greek government debt. In other words they made the Greek Cypriot banks take a significant loss. Now, one year later, the Greek Cypriots need a bailout because of the terms of the Greek bailout. Other than that Greek Cyprus's economy is doing just fine—the only problem is bad loans to other countries. Of course part of the crisis is because Greek Cyprus has made itself a tax haven. This has attracted massive amounts of Russian capital, and it is unpalatable to make Eurozone tax payers pay so that rich Russians do not suffer.

I have to agree with the quotes above. This is a fundamentally bad idea, and the reason it is can be understood using basic Microeconomics. The problem is not actually with what is happening in Cyprus, the problem is that the Eurozone has now made a statement that bank deposits in the Eurozone are not safe. If the government is in a bad financial situation they may take a significant portion of your savings without notice. Anyone rushing to deposit money in Italy now? I certainly would not. In fact if I had savings in Spain—for instance—I would

¹<http://edition.cnn.com/2013/03/18/business/quest-opinion-cyprus-bailout/index.html>

²<http://connecttheworld.blogs.cnn.com/2013/03/19/breaking-down-the-cyprus-bailout-deal/>

³<http://www.bbc.co.uk/news/world-europe-21817197>

be hurrying to withdraw them. And this is the fundamental problem. Banks, in reality, are nothing more than a game of trust. If we all trust in banks then they can do wonderful things for the economy, but if we all stop trusting banks the banks will fail, causing an economic crisis merely because of this failure of trust. You should never give just cause to distrust banks.

1 Feeding the Dream

So what is it that banks do? They lend money. There is a popular tendency to think of this as something ugly. You know, the rich tycoon goes to the bank and says "give me a million dollars so I can go cut down virgin rainforest." OK, alright, that sort of thing does happen. But this is not the bread and butter of what banks do. Most of their loans are so that people can buy a house, or buy that fabulous car that you've always, *always*, wanted but don't quite have enough money for. They feed your dreams.⁴ Say you have a dream of opening a chain of (beef) bratwurst shops in Turkey.⁵ You're going to need a lot of money to realize this dream. You're going to have to build a factory to produce the bratwurst, and another factory to produce proper German sauerkraut⁶ to go on your bratwursts. How are you going to feed this dream? You go to a bank and borrow money.⁷ And not only is this good for you but it's good for all your customers. They enjoy your bratwursts and have a better life. Don't forget your employees, your suppliers, and so on, and so on. In other words banks lending money is fundamental to the growth of the economy. Without banks I expect the world's economy would be no more than one fifth of its current size, and that is a very generous estimate. I could guess one percent and not get a lot of argument from economists.

⁴For an excellent example of this, watch "It's a Wonderful Life." <http://www.imdb.com/title/tt0038650/> Not only does the hero feed dreams but there's also a bank run in the movie. Man, did they make it for this handout or what? It's in Bilkent Library's video collection, <http://ehis.ebscohost.com/eds/detail?vid=2&sid=8886bc90-2b06-498b-b670-aa60cf91c652%40sessionmgr115&hid=106&bdata=JnNpdGU9ZWRzLWxpdmU%3d#db=cat00040a&AN=bilk.340626>

⁵A bratwurst is a type of German sausage—usually made with pork. The best are actually produced in Wisconsin these days. I looked at a bratwurst in an airport in Germany a little while ago and it looked awful. My Sister-in-Law said it was the same throughout Germany. (She lives in Wisconsin.)

⁶This is not the same as lahana tursu. I regularly consume lahana tursu and just wish it was a proper German sauerkraut. Sigh. If you realize this dream drop me a line and I'll buy lots of your sauerkraut.

⁷For those of you who believe in the Islamic rule against lending let me point out there is an easy solution. Instead of lending you the money the bank becomes a part owner of your business, and as you earn money you buy your business back from the bank. In the end the two mechanisms are the same.

2 How does a deposit earn interest?

Say that you deposit 20 thousand TL in a bank. How can the bank afford to give you more than 20 thousand TL back at the end of the year? Does it just magically sit in their vaults and grow bigger? No, the reason they can give you more than 20 thousand TL back is because they lend out the money—to people like our bratwurst entrepreneur. But this means that your money is not in the bank at all. It is in the hands of the bratwurst entrepreneur, who has promised to give the money back in small amounts, but the capital itself is being used to build a bratwurst factory. Now the Bank usually holds some of your deposit in its vaults—after all you might want to withdraw some money on a day to day basis—but most of your money is being invested. You want them to do this because you want a high interest rate, and the interest rate on the money they hold is zero.

3 Banks and Trust

But now you get to the nub of the problem. If you went to the bank and demanded your 20 thousand TL tomorrow the bank would be legally required to give it to you. But they don't have the money! How can they give you your money when it's actually in the hands of our bratwurst seller? Well, one thing they could do is call in their loans, but that's going to cause a problem because the bratwurst entrepreneur doesn't have it either. He's given it to a construction company to build his factories. They've used it to buy cement and the other things they need, and so on. In effect while in a crisis banks sometimes do this it doesn't work, and the ripple effect can cripple the economy.⁸ So what they do is they take your 20 thousand TL out of their total reserve for all their deposits and just have less money for a while. When the bratwurst entrepreneur and others pay back their loans they use it to beef up their reserves and make lower profits.

But what if you and all your friends went to the bank and demanded your money? Let's assume you have lots of friends. Well now the bank has a more serious problem. If you don't have enough friends then they may be able to pay all of you back, but it's going to hurt. So now say you are close personal friends with everyone in Turkey, and you convince all of them to withdraw their money. What happens now? The banks will collapse, and with them the Turkish economy.

4 Bank Runs

What could cause you to demand all your deposits back? Well it could be because you lost your job, it could be because you want to buy a house, there

⁸This is part of the reason that banks require assets to guarantee a loan. If you want, say, half a million TL you need to offer your house as a guarantee that you will pay it back. An unfortunate aspect of this is that poor people can often not get loans.

are many reasons you might want your money. Some of them—like losing your job—are often correlated between different people. If the macro economy goes bad then lots of people lose their jobs, and need cash to cover living expenses. So banks are often in situations where a lot of people demand their money simultaneously.

Now, what would be the sensible thing to do if **your** economic situation is fine but **other people's** economic situation is in bad shape? It depends critically on how many of these other people there are, and how much money they have deposited. If there's not enough of them (the usual state) you just don't worry about it. After all Banks can lose money too, they've promised you $x\%$ interest and so you don't care. But what if you think there are too many other people out there who want their money back? Now we get into a crisis state. The banks are legally required to give people their money as long as there is money in their vaults. When there is no more money in their vaults (and whatever they can get by calling their loans) they are bankrupt, and all further claims have to be settled in the courts. Usually for kurus on the lira.

So what should you do? *If you think the bank may collapse you should withdraw your money immediately.* But, wait a minute, this is going to deplete their reserves. That means that withdrawing your money is going to make it more likely that the bank will fail. So this reinforces your motivation for withdrawing your money!

Your actions could cause a bank failure, making your actions sensible.

A self fulfilling prophecy.

Oh no.

This is what is called a "bank run." It is indeed a self fulfilling prophecy. If you think that the bank will collapse then you should withdraw your money immediately. If enough people think like you then they should do the same, leading to a bank collapse.

Now above I mentioned that there could be reasons to think that a lot of people will want their money. But the fundamental thing you have to realize is that these reasons are not actually necessary. All that is required is that you believe that other people believe to a high enough degree that they should withdraw their money.⁹ There might be no economic fundamentals at issue.

A crisis of confidence can cause a bank run, which can lead to the collapse of banks, and cause a real economic crisis.

5 A Simple Model of Bank Runs

Let us assume that there are I consumers all of whom deposit one unit in the bank. Each individual $i \in \{1, 2, 3, \dots, I\}$ will have a demand $d_i \in [0, 1]$ for cash

⁹A Bilkent professor, Nuh Aygun Dalkiran, actually has characterized conditions under which such a crisis in confidence can occur. It is a technical paper about beliefs, but this is a link:

http://link.springer.com/chapter/10.1007%2F978-3-642-33996-7_8

in the current period—this demand will usually be random. The bank can lend out this money to J investors, each of whom demand one unit and will pay back $R > 1$ times the original investment. They will pay back in the current period $p_j \in [0, 1]$ —these payments are also stochastic because investments may go bankrupt or the loan may need to be renegotiated. The bank is required to have enough cash on hand to meet their depositors' demands. We will treat the bank as if it is maximizing the return on its deposits. In essence this means they will be minimizing over the amount of reserves they hold, $\rho \in [0, 1]$. While all countries have a required reserve ratio, banks almost always hold more money than this. In Turkey (and most countries) it is approximately 10%, though of course the amount depends on the type of deposit.

Let the total demand for assets be $D = \sum_{i=1}^I d_i = d_1 + d_2 + d_3 + \dots + d_I$, and the total flow of payments be $P = \sum_{j=1}^J p_j = p_1 + p_2 + p_3 + \dots + p_J$ then a bank wants to maximize the returns on their deposits:

$$\max_{\rho} I\rho + I(1 - \rho)R$$

such that:

$$D \leq I\rho + P$$

or they can meet their demand for money in the current period. The solution to this is obvious, you want to choose ρ such that $D = I\rho + P$, assuming $D > P$ $\rho = \frac{D-P}{I} = \bar{d} - \frac{P}{I}$, where \bar{d} is the average demand of a customer, and $\frac{P}{I}$ is the average amount of repayments per customer. Notice this is not the same thing as the average repayment, which would be $\frac{P}{J}$, in general it will be much lower than this.

Now consider the fact that these are going to be stochastic, to properly consider this case let's be a little more precise about the bank's profits. More precisely it is:

$$\pi(\rho) = \begin{cases} I\rho + I(1 - \rho)R & \text{if } D \leq I\rho + P \\ -F & \text{if } D > I\rho + P \end{cases} ,$$

where $F > 0$ is the bankruptcy cost of the bank. Given this modification the bank's real objective function is:

$$\Pr(D \leq I\rho + P)(I\rho + I(1 - \rho)R) + \Pr(D > I\rho + P)(-F)$$

Recognizing that $\Pr(D \leq I\rho + P) + \Pr(D > I\rho + P) = 1$ we can rewrite this as:

$$\Pr(D \leq I\rho + P)(I\rho + I(1 - \rho)R) + (1 - \Pr(D \leq I\rho + P))(-F)$$

$$\Pr(D \leq I\rho + P)(I\rho + I(1 - \rho)R + F) - F$$

The fact that they get the high payoff only if $D \leq I\rho + P$ puts upward pressure on their reserves, but they still want to keep it fairly small. This more or less summarizes the bank's real objective function. They want to minimize ρ but keep it

high enough to meet the demand for cash. Notice that if $\Pr(D \leq I\rho + P) = 1$ then banks will always decrease ρ , or in other words their optimal plan includes the possibility of bankruptcy.

Now let us look more carefully at d_i . It will be a function of many things, first of all your income, w_i , secondly your consumption plans C_i , and then—critically—it depends on the probability of a bank failure, which we can denote as $\Pr(D > I\rho + P)$. Because of this it will also depend on your risk aversion, $\sigma_i > 0$, with higher values of σ_i meaning you are more risk averse. Thus

$$d_i = d(w_i, C_i, \Pr(D > I\rho + P), \sigma_i) .$$

Now the C_i 's will be more or less independent, but obviously the incomes, w_i , will be positively related. If you are doing well it is more likely that others are, and if the economy is in crisis everyone is likely to have low w_i 's. Obviously it will be strictly increasing in the probability of a bank failure, $\Pr(D > I\rho + P)$, and we return to the circularity of the argument. If $d_1 = 1$ (you demand all of your deposits) then $\Pr\left(d_1 + \sum_{i=2}^I d_i > I\rho + P\right)$ is increased, possibly making $d_1 = 1$ optimal.

For example assume that your personal situation is fine, but you believe that a subset of the depositors, \hat{I} , are planning on withdrawing all their money. Will this cause a bank run? A sufficient condition is in the case where everyone else demands 0, thus it will if:

$$\hat{I} > I\rho + P$$

And as long as $\rho < 1$ and $P < (1 - \rho)I$ there is always a critical $\hat{I} < I$ such that this is true. Notice that if $P = (1 - \rho)I$ this would mean that the bank demands complete repayment of all loans in one period, in other words they aren't actually lending at all. So the only real condition is $\rho < 1$, which is equivalent to saying the bank will give you some interest on your deposit.

However this condition is not necessary, indeed your beliefs don't need to actually be true at all. If you *believe* this is going to happen, then you should withdraw your cash. This should make others worried, they should not believe that $\Pr(D > I\rho + P)$ is higher, and if they believe it is high enough they should withdraw their cash.

So how would this happen? First of all, generally speaking, there will be some small negative shock. This shock will be enough that the very risk averse (with very high σ_i 's) will withdraw their funds. This will lead to the less risk averse believing they should withdraw their funds, and so on, and so on. In the end we will be in a situation where everyone should run to the bank as quickly as possible to get their cash out.

But the economic shock is not necessary, it could be nothing more than a *rumor* that a bank was going to go bankrupt. If enough people believe this then it will start a bank run, and this has actually happened. For example in July of 1893 there were city wide bank runs in Kansas City, Kansas and Portland, Oregon in the United States. These banks all closed—basically refused to hand out cash for a while—in order to survive. After proper investigation it was found

that 90% of these banks were solvent at the time of the bank runs. Fear itself nearly caused the collapse of these banks.¹⁰

Notice, by the way, the danger of rumors in such an environment. If you ignore rumors this will decrease the probability of a bank run, making ignoring these rumors *usually* a good idea. But when a bank run occurs you may only get news of it by a rumor. So what do you do?

5.1 A Simple Game Theoretic Model

Can we transform this into a simple game? Yes, assume there are I people who each have one unit to deposit. They can either deposit it in their mattress (M) and get zero return, or they can deposit it in the bank (B) and get $1+r$ ($r > 0$) if the bank is liquid. Thus i 's strategies, S_i are $\{M, B\}$. Let s_i be the strategy they choose, and s_{-i} be the strategies of all other people. Then a simple reduced form model is that their utility is:

$$\begin{aligned} u(M, s_{-i}) &= 1 \\ u(B, s_{-i}) &= \begin{cases} 1+r & \text{if } K-1 \text{ other people or more choose } s_k = B \\ 0 & \text{else} \end{cases}, \end{aligned}$$

where we assume $K \leq I$. The argument for why $K > 1$ is often necessary is best understood by looking at the model of Bank's optimization above. This game obviously has two pure strategy equilibria, everyone choosing M and everyone choosing B . Let's look at a simple representation of the mixed strategy equilibrium for a moment, to do this we have to calculate the expected utility B :

$$E[u(B, s_{-i})] = \Pr(\text{at least } K-1 \text{ other people choose } s_k = B)(1+r).$$

Quite simple, no? Now let's write $\beta = \Pr(\text{at least } K-1 \text{ other people choose } s_k = B)$, and then the critical β^* such that both B and M is optimal is:

$$\begin{aligned} u(M, s_{-i}) &= E[u(B, s_{-i})] \\ 1 &= \beta^*(1+r) \\ \beta^* &= \frac{1}{1+r}. \end{aligned}$$

Notice that this is decreasing in r , in other words if the bank is offering a higher interest rate you are more willing to take a chance. If we write β_i for i 's beliefs about the probability at least $K-1$ other people will deposit in the bank, then the equilibrium condition for $s_i = B$ to be optimal is clearly just: $\Pr(|k \in I \setminus i, \beta_k \geq \beta^*| \geq K-1) \geq \beta^*$ —in words the expression is that the probability at least $K-1$ other people think that the probability of the bank being solvent is high enough. Thus $\beta_i = \Pr_i(|k \in I \setminus i, \beta_k \geq \beta^*| \geq K-1)$, where we subscript the probability by i because people may not have the same beliefs that this condition is true.

¹⁰<http://eh.net/encyclopedia/article/wicker.banking.panics.us>

Now we can see how we can get a bank run. Assume that everyone is depositing their money in the bank. Then if i observes k choosing M , this should decrease his β_i . This can cause him to choose M . This, of course, depresses other player's β_j more, potentially causing a self fulfilling prophecy.

Now why would k choose M in such an environment? In general it could be because he's risk averse, or is just pessimistic. Who knows? Well we can model his reason by adding a facet of realism to our model. Keeping the money in the mattress (in hand) means that you can spend it on things you want to buy. This will give you some positive return, which obviously will be person specific, call it ε_i . With this modification:

$$u_i(M, s_{-i}) = 1 + \varepsilon_i .$$

Now we need to define β_k^* as:

$$\begin{aligned} u_k(M, s_{-k}) &= E[u(B, s_{-k})] \\ 1 + \varepsilon_k &= \beta_k^*(1 + r) \\ \beta_k^* &= \frac{1 + \varepsilon_k}{1 + r} . \end{aligned}$$

Now in such models ε_k is private information—only k knows ε_k , but it is assumed to have a known common distribution. Using this we can write $\beta_i = \Pr(|k \in I \setminus i, \beta_k \geq \beta_k^*| \geq K - 1)$, and not worry about i being pessimistic or risk averse. Then we can rewrite this as:

$$\beta_i = \Pr\left(\left|k \in I \setminus i, \beta_k \geq \frac{1 + \varepsilon_k}{1 + r}\right| \geq K - 1\right) .$$

and notice that as long as it's possible that $\varepsilon_k > r$ we must have that $\beta_i < 1$. This is because it is certainly possible (though it may have a very low probability) that for everyone in the society $\frac{1 + \varepsilon_k}{1 + r} > 1$ and then conditional on this $\Pr\left(\left|k \in I \setminus i, \beta_k \geq \frac{1 + \varepsilon_k}{1 + r}\right| \geq K - 1\right) = 0$. In such an environment a simple plan for everyone to follow is to use a *cut off strategy*:

$$s(\varepsilon_i) = \begin{cases} B & \text{if } \varepsilon_i \leq \varepsilon^* \\ M & \text{if } \varepsilon_i > \varepsilon^* \end{cases} .$$

in other words deposit in the bank if your personal needs for cash (ε_i) are not too high. A Pareto Efficient strategy would have $\varepsilon^* = r$, you obviously shouldn't deposit in the bank if you need the cash more than the benefit. However we can see that this is not the equilibrium, $\varepsilon^* < r$ in equilibrium. What does this mean? Due to fear that others are going to not deposit in the bank people will withdraw their cash. To see this is the equilibrium let's rewrite β^* in terms of these probabilities alone, and we will assume everyone uses the same strategy so we can drop the i subscript.

$$\beta(\varepsilon^*) = \Pr(|k \in I \setminus i, \varepsilon_k \leq \varepsilon^*| \geq K - 1) < 1 .$$

Then in the mixed strategy equilibrium we can find ε^* by:

$$\begin{aligned}1 + \varepsilon^* &= \beta(\varepsilon^*)(1 + r) \\ \beta(\varepsilon^*) &= \frac{1 + \varepsilon^*}{1 + r}.\end{aligned}$$

But above I explained why we know that $\beta(\varepsilon^*) < 1$. So that means $\frac{1 + \varepsilon^*}{1 + r} < 1$, $1 + \varepsilon^* < 1 + r$, $\varepsilon^* < r$!

Bank runs can happen when everyone in society would rather they do not. They can be caused by nothing more than fear that others are going to withdraw their cash.

Now you can understand how a cascade could get started without relying on any unmodelled arguments. Say that i observes that k is planning on $s_k = M$, this will obviously strictly decrease his β_i^* , and this would result in a strictly lower ε_i^* . If he's at a critical ε_i , he will choose $s_i = M$, this will lead to the same effect in others, and so on. And the original person might have chosen $s_k = M$ by mistake. Doesn't matter, we can get a bank run without any change in the economic fundamentals.

6 Concluding Comments

Do you know why Turkey was relatively unaffected by the 2008 US banking crisis? Because of the 2001 Turkey banking crisis. Because of this Turkey put in place very sound and sensible regulations on banks, limiting the risk they could take when investing your capital. While banks do feed dreams, it is a rare entrepreneur who can get all the capital they need from banks, the Turkish government (and most others) simply tell them they can not fund risky investments like that. Banks are heavily regulated the world over to make sure bank runs do not happen, and Turkey is better protected than most. So what would I say is the probability of a bank run in Turkey? Well first of all most of you don't care, small deposits in Turkey (like the US) are insured by the government. But regardless, I would be shocked to hear that one happened.

The US would also like to claim that they properly regulate banks, but of course the recent financial crisis belies their words. In the economic history of the US there were repeated bank runs. Because of this there is federal deposit insurance, small savers have their deposits insured by the federal government. There are also many other regulations, though obviously not enough.

This analysis also explains why the US government—and most sensible governments the world over—reacted to the banking crisis by bailing out the banks. This obviously caused a popular outcry. It's like feeding the fox because he's eaten all the chickens. But it was, and is, absolutely necessary. Why? Because if they didn't a lot of major banks would have gone bankrupt. If a lot of banks are going bankrupt the environment is ripe for bank runs.¹¹ If there are enough

¹¹Let me mention at this points that banks commonly lend each other capital. So if bank A goes bankrupt this greatly increases the chances of bank B going bankrupt. This is a sound

bank runs then the economy would have collapsed even worse than it already did. If the government hadn't "fed the fox" and hemorrhaged the problem at the start then we probably would have been in for a depression that would have made the Great depression of the 1930s in the US look like a mild recession. And this time it would have been world wide. It is unpalatable, but it was absolutely—fundamentally—necessary for survival.

The bottom line, the part you need to understand, is that banks are and should be a trust game. If enough people trust in banks then the world profits tremendously. If people loose their trust that lost of trust alone can cause a collapse of the banking system and this will cause a collapse of the economy. Scary, I know, but don't worry too much. Governments the world over are trying to protect this dream as hard as they can.

This is why it is so disturbing that the Eurozone leadership has decided to violate this trust. They have decided that Greek Cypriots (and a lot of Russians who have deposits there) will have to pay for the Greek crisis by loosing a lot of their deposits. Oh, I can see the... poorly founded logic. If Greek Cyprus was not in the Eurozone then the crisis would have led to a depreciation of their currency. This would have been equivalent to at least a 10% tax on savings. However I have always believed one task of government was to mediate the risk of the marketplace. Fortunately the Greek Cypriot legislature voted to reject this proposal. Strikingly not a single legislator voted in favor, the governing party abstained and everyone else voted against it. But the damage to confidence has been done. The Eurozone, to paraphrase Richard Quest, has "shot itself in both feet."

economic practice, but it does mean that in times of crisis there can be contagion—one bank failure leading to others.