A Quant's View of Negative Interest Rates

The world has negative interest rates. How did that happen?! What does it mean for quantitative modeling? (Suggested sub-title / deck)

In rough numbers, nearly € 2 trillion of the € 6 trillion of outstanding Eurozone sovereign debt currently has negative yield. That's not just amazing – it's stunning! Negative yields for German Bunds go all the way out to seven years in tenor. Though we focus on Eurozone countries here, let's also note that the central banks of Switzerland, Sweden, and Denmark impose negative deposit rates. Readers of this column are financial professionals, but let's ask and discuss simple-sounding questions.

What is the meaning of negative interest rates?

With negative yields, the lender ultimately receives a lower amount in future interest and principal payments than it pays originally for the bond. For example, the borrower may pay a periodic coupon, but the total undiscounted value of all coupons and principal payments is less than the current bond price.

As of, say, just five years ago, virtually all financial experts would have proclaimed sustained negative interest rates to be practically impossible. First, there have never been sustained negative rates through history – even after watching Japan live through miniscule but positive rates since the 1990's. (Short-term rates in the Swiss franc fell below zero briefly in 1979.) But history is merely an observation rather than an argument or proof. Second, it seemed that lenders would always be free not to lend to a borrower with negative yield. In principle an individual, a bank, or a business could hold physical cash in the form of bank notes. The reality, though, is that it's not feasible to hold large sums – millions and billions of euros – in bank notes.

Institutions with significant cash must hold this cash in electronic form and are therefore hostage to negative rates on deposits. With negative "cash rates," lenders have incentive to buy Eurozone sovereign bonds with negative yields when such yields are greater than the cash rates.

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Why are Eurozone interest rates negative?

It's the ECB (European Central Bank). First, the "deposit rate" at the ECB is negative 0.20% per annum. Excluding physical bank notes in the vaults, Eurozone banks hold their cash with the ECB. Thus, this negative cash rate incentivizes banks to make loans or buy other assets rather than hold cash. Second, the ECB announced its quantitative easing (QE) program in January 2015 and began this program's planned purchase of Eurozone sovereign debt this month. As a large buyer of such debt with the announced intention to pay prices at negative yields, the ECB is a deliberate enabler of below-zero interest rates.

Yet a third contributor is the precarious financial strength of most Eurozone banks. Through requirements of Basel III, the national central banks, and the ECB, banks must reduce the risk of their assets relative to their equity and also improve their liquidity positions. This regulatory regime encourages banks to buy sovereign debt through favourable (and arguably over-optimistic) risk and liquidity assessments. Combining the negative ECB deposit rate with evolving regulations, it is rational for Eurozone banks to buy highly rated sovereign debt with low, zero, or negative yield as long as the yield exceeds the deposit rate.

Are negative interest rates a tax on cash?

Yes! Certainly the ECB deposit rate is not negative due to any fee or operational cost of holding bank reserves. For a sovereign entity that sells debt at a price higher than its repayment obligation, the excess amount goes to funding government operation – just like a tax. The ECB's deliberate intent both for its deposit rate and for the negative sovereign yields is to penalize holding cash and near-cash instruments.

While these circumstances drive banks to the "near-cash" sovereign debt purchases as we noted above, non-bank corporate entities generally have more flexibility. The ECB may hope that corporates will increase capital expenditures and/or hire more people to increase production. But the necessary demand may be absent. The more likely consequence is that companies will dissipate the cash to shareholders through dividends and

stock repurchases. The loss of cash in this manner harms the creditworthiness of these firms.

How does a Quant model negative interest rates?

In the time-honored sense of what we call a "quantitative model" or a "stochastic process," there is no possibility of modeling negative interest rates. The dominant core principles of interest rate modeling of the past decades have been that: (i) interest rates don't go negative; (ii) there must be consistency with current bond prices; and (iii) there must be parametric consistency with historical data. Clearly the first principle is gone (forever?) and there is no intuitive and convincing lower bound to replace zero. Also, all historical data now strikes us as irrelevant to the current paradigm. So there is no history to guide an appropriate contemporary model approach.

One might argue that, though we must discard log-normal models since they incorporate zero yield as a strict lower bound, the quant analyst may keep the familiar normal distribution "random walk." This random walk, also known as Brownian motion, can simply wander around in negative yield territory. Yes, we can espouse the equations, draw the diagrams, and create the computer code, but it would be wrong.

In the original Brownian motion, Robert Brown observed the motion pollen grains under a microscope. Ultimately, the source of the motion was numerous random, small, invisible collisions from lesser objects. The statistical aggregate of these "numerous collisions" created the observed motions. In the financial world analogy, the "numerous collisions" are individual trades in the marketplace. The analogy fails when there is simply a dominant force, the ECB, setting the prices through its deliberate actions.

Can foreign exchange rates go negative?

The question seems absurd! How can an FX rate be negative? To be specific, how could the EUR-USD exchange rate – expressed as $ / € - go negative? It might conceivably fall arbitrarily close to zero, but how could it go negative?

We raise the question only to make the point that one cannot dismiss it by saying "that's never happened" or "nobody would choose to exchange a dollar for a negative number of euros (*i.e.*, a euro liability)." Though it's a stretch, imagine that owning euros in this future scenario entails an obligation such as negative interest rate or another tax or payment obligation that could somehow exceed the long euro position itself. When offered the euros, then, a person or institution might also demand U.S. dollars in order to take the euro position (and its implied liability). That's a negative FX rate!

Will Eurozone sovereigns issue bonds with negative coupons?

One of our friends wondered recently if Germany, for example, might issue five-year debt at par with a negative coupon. Given that the secondary five-year Bund yield is negative, the simple math requires a negative coupon for new debt. Think of the consequences! The bondholder would need to send in more money (the negative coupon) on every payment date. It's an operational nightmare!

Of course, there are simpler alternatives. Germany would likely choose to issue its debt with a zero or positive coupon and then expect a sale price in excess of par to give the target (negative) yield. Or it could sell debt with a negative coupon at par, but then simply net the negative coupon payment when due against the bond principal. Strange solutions that convince us again that negative interest rates are counter-intuitive!

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