Negative Rates in Europe: Implications for Finance Teaching and Practice

JAYANTH R. VARMA
Finance & Accounting Area
Indian Institute of Management
Ahmedabad, INDIA
jrvarma@iima.ac.in

VINEET VIRMANI
Finance & Accounting Area
Indian Institute of Management
Ahmedabad, INDIA
vineetv@iima.ac.in

Abstract: - Many European countries have introduced negative interest rates, and the Swiss franc denominated bonds of many US companies now trade at negative yields. Why do central banks push interest rates negative and what are the costs of benefits of doing so? How much more negative can rates go or have we reached the limit in some countries? How does a bank remain profitable when you have to pay your borrowers to take money from you? How do investors allocate their portfolios in an environment where the government bond is offering not a risk free return, but a guaranteed loss? What happens to the equity risk premium in such a world? How do companies manage working capital in a situation where you want to pay your suppliers instantly and want your customers to delay their payments to you? What happens to standard present value formulas in a negative rates world? Does the present value of perpetuities actually become negative? These are a few of the disturbing questions that arise when negative interest rates upend our traditional assumptions about how the financial system works. Our article addresses these questions from the point of view of managers and educators trying to make sense of this brave new world.

Key-Words: - Corporate finance, Interest rate models, Monetary policy, Option pricing, Negative rates, Risk management, Zero lower bound

1 Introduction

When the world's oldest central bank does something new, everybody sits up and takes notice. In what was perhaps one of the most dramatic and understated moves by a central bank in the post Global Financial Crisis (GFC) world, in July 2009, the Sveriges Riksbank announced an interest rate of −0.25 percent on its one-week deposit facility. The economic commentators worldwide were taken by a surprise. It was an unprecedented event by any standard. Even the lowest point of the Japanese deflation had not invited a negative interest rate policy. Whether the policy would work was an open question because Swedish banks are not known to use deposit facility actively, but if negative rates were considered unthinkable in the pre-GFC world, the Riksbank certainly broke that illusion.

While central banks historically have been known to use multiple instruments to deal with economic downturns, the response of central banks post GFC has been both aggressive and unconventional. After the president of the European Central Bank (ECB) Mario Draghi announced a fresh round of quantitative easing to begin in January 2015, the Swiss central bank (SNB) pushed the envelope of surprising participants even further. The Swiss franc has traditionally been considered a safe haven currency. A pegged Swiss franc – euro rate since 2011, however, meant the SNB had to stave off increasing capital flows by purchasing foreign currency assets almost endlessly. By the end of 2014, its foreign exchange reserves, at 80 percent of its GDP, were the largest among all G7 countries. The imminent easing by the ECB would have meant hundreds of billions of euros required by the SNB to maintain the peg. To ward off impending capital flows, on December 18, 2014, the SNB also announced a negative policy rate, and on January 15, 2015, out of the blue, decided to abandon the peg altogether, causing havoc in the foreign exchange markets.

2 The New Normal

It wasn't just the Swedes and the Swiss, however. During the GFC, several central banks cut their policy rates to zero. The United States, for example, set a target range of 0 to 0.25 percent for the policy rate to avoid the risk of short-term rates going negative. But even then the open market interest rates did go marginally negative at times.

For example, in December 2008, three-month U.S. Treasury Bills traded at a negative yield for the first time ever. In the primary market, the bills were auctioned at a yield of +0.5 basis points, but in the secondary market, they traded at a yield of −1 basis point. Then it was an issue of credit risk—at the height of the crisis, it was difficult to decide which banks were safe and therefore conservative investors preferred to hold a direct obligation of the U.S. government even if that meant a marginal negative yield.

While the Riksbank was the first to flirt with negative policy rates in July 2009, since then, as Figure 1 shows, other than the ECB (June 2014), three other countries have experimented with negative rates, including Denmark (June 2012), Switzerland (December 2014), and Japan (January 2016).

2.1 The short and the long of it

Even though for much of the last hundred years, central bank policy rates have almost never been below 1 percent, and short-term interest rates in the open market were rarely below 0.5 percent, what has been historic in the last five years is not the fall in developed country central bank policy rates to below zero levels, but an unprecedented fall in the yields of long-term bonds.

Sidney Homer and Richard Sylla's monumental History of Interest Rates documents the path of interest rates from around the world over the last 5,000 years [1]. Prior to the late 1990s, the lowest long-term free market interest rates that they record is 2.2 percent in 1896 for perpetual debt (consols) issued by the United Kingdom. Slightly lower levels (1.93 percent) were recorded in 1946 for U.S. long-term bonds, but some observers would regard this period as one of financial repression in the United States. Despite the sustained low level of rates even in Japan, the 10-year Japanese Government Bond has averaged a yield of around 1.25 percent.

After the GFC and the Eurozone crisis, the modern financial markets have had to get used to not just negative policy rates, but negative rates across the term structure. And the scale is staggering – as of mid-June, 2019, almost $12.5 trillion worth of long-term sovereign debt had negative yields [2].

As Figure 2 shows, the government bond yields in many countries remain negative at all maturities up to 10 years more than a decade after the GFC. It can also be seen that in some countries, the problem of negative rates has worsened from 2016 to 2019. Table 1 highlights this worsening problem in a different way using forward-forward rates. The 5-year 5-year forward rate is the market expectation (extracted from the zero coupon bond yield curve) of what the five year interest rate will be five years from now. These rates have fallen significantly between 2016 and 2019 and are now negative in both Germany and Switzerland. Similarly, the market expectation of what the four year rate will be one year from now has also become more negative during the last three years. The market now expects the problem

of negative rates to last longer than what it expected in 2016.

2.2 Less than zero: Unlimited monetary easing

The cornerstone of modern monetary policy in developed countries is the belief that a credible and moderate inflation target (of about 2 percent) enables growth as well as acts as an automatic stabilizer against negative shocks [3].

So, if the inflation target is met, a negative demand shock leads to fall in real wages, even if nominal wages stay the same leading to lower unemployment than otherwise. A more-than zero target rate of inflation also creates a buffer for the central banks to pursue easy monetary policy without worrying about the zero lower bound. And to the extent that expectations are important, a credible monetary policy also ensures that in the wake of a negative shock, consumers and corporations automatically adjust to a lower real rate enabling higher consumption and investment in the "next round." And as demand gets pulled back, automatic stabilization creates environment to revert to the natural real rate.

The central banks have a more difficult problem when low demand happens in the times of financial imbalances, meaning extraordinary increases in asset prices and credit. The build-up and unwinding of such imbalances are often accompanied with costly economic adjustments and systemic crises. Before the GFC, the Asian crisis and the Japanese deflation were prime examples of such episodes. The impact of the GFC and the Eurozone crisis has been only amplified because of the ease and speed of cross-border capital flows.

It is in these times that the central banks have resorted to unconventional and aggressive monetary policy measures like quantitative and qualitative (or credit) easing leading up to or accompanied by negative policy rates [4]. Broadly, these have worked in the following ways [5]:

- Change in size (quantity) of central bank balance sheets: Purchasing long maturity bonds to push down sovereign long-term yields.
- Change in composition (quality) of central bank balance sheets: Purchasing long maturity distressed asset-backed and mortgage backed securities from financial institutions with a view to causing portfolio rebalance and lowering of long-term corporate bond yields and risk premia across asset classes.
- Announcements to keep short-term nominal rates to near-zero levels: Steering expectations of future short-term rates via forward guidance.
- Negative rates on deposits: Announcing negative rates on deposit facilities (for large corporations and banks) with a view to further rebalancing of portfolio to risky assets.

With a virtually coordinated response of all developed country central banks, the short-term interest rates globally have gradually drifted toward zero. And to the extent long-term nominal rates reflect a combination of expected real rate, inflation expectations, and risk premia, with continuing lack of demand, falling risk premia, and stable inflation expectations, long-term rates have also ended up in the negative region [6].

2.3 Making sense of the zero lower bound

Bond prices like all other assets (with no embedded liability) must be non-negative. Economic theory is silent on the sign of the interest rate. If one expects to be poorer in future (as when saving for retirement), even negative interest rate investments may be optimal (diminishing marginal utility of money). For example, real interest rates are often negative (interest rates less than expected inflation) for extended periods of time and people are happy to adapt to it

The zero lower bound (ZLB) comes from the existence of cash which offers a zero interest rate. Actually, the ZLB is a bound not on the interest rate, but on the contango on money. Money (being the unit of account itself) can neither be in contango nor in backwardation. The standard cost of carry model for futures pricing applied to money:

$$0 = \text{Contango} = \text{Risk-free rate (R)} + \text{Storage cost (X)} - \text{Convenience yield (Y)}$$

In normal times (R > 0, X < Y), with contango zero in equilibrium, when money supply is reduced, the risk free rate (R) rises and the convenience yield (Y) also rises. In times of unlimited monetary easing, abundant liquidity drives the convenience yield (Y) down and ultimately it remains approximately zero. And again, contango zero requires a slightly negative interest rate (R) since the storage cost (X) is not zero. The lower bound on the negative interest rate is thus the storage cost.

3 The Investor Perspective

3.1 Asset allocation

The most important investment decision is the allocation of savings between the principal asset classes—bonds, equities, and physical assets like real estate. Negative interest rates have a huge impact on this decision, but the best investment strategy is by no means clear.

On the one hand, negative rates are clearly an attempt by the central bank to make bonds an unattractive investment in the hope that it'll push investors into buying riskier assets which will encourage business investment. If one believes that the central banks will succeed in this objective, it makes sense to shun bonds and buy equities or physical assets. This is because when the economy revives, (a) interest rates will climb back above zero and inflict massive losses on those who bought bonds at negative yields and (b) risky assets will do well and earn good returns.

Strengthening this argument is the perception that central banks will not allow risky assets to fall too much, and will step in with various measures to prop up these markets. If this perception is correct, then central banks are putting a floor under the equities markets, but not under the bond markets. The traditional notion of bonds being safe and equities being risky now needs to be revisited.

On the other hand, there is a large body of experimental and empirical evidence in favour of Daniel Kahneman's prospect theory, which suggests that people tend to become risk-seeking when faced with sure losses [7]. Rather than accept a certain loss, they'd take a risky gamble that could lead to much larger losses so long as it has some chance of avoiding the loss altogether. Meaning, even a risky gamble with higher expected loss may be preferred to a lower but certain loss. And that may mean a role-reversal for equities and bonds in portfolios.

So, investors may take a duration risk to avoid a certain loss of principal. An investor with a four-year holding period could buy a ten-year bond at a negative yield gambling on yields falling even further over the next four years so that the bond can be sold at a profit. For these investors, bonds have become like equities – something to be bought not for yield, but for a highly risky chance of a capital appreciation. Some other investors have turned to stocks paying high dividends in order to earn a yield while ignoring the risk of capital losses. It has, therefore, been suggested that bonds are the new equities and equities are the new bonds. Prospect theory would explain this behaviour very well.

Stacked against all these arguments, however, is the possibility that the situation might be so bad that the central banks might fail to revive the economy, which could push the world into deflation for an extended period of time. In this scenario, bonds (and more specifically government bonds) are an excellent investment even at negative yields. First, adjusted for deflation (falling prices of goods), they may offer a decent real return. Second, deflation is quite bad for many other assets – many companies may go bust leading to large losses in equities and corporate bonds. In a deflationary scenario, real assets might also face large capital losses.

In short, the asset allocation question for the investor boils down to a bet on whether the central banks will succeed or fail in their effort to revive the economy.

3.2 Fixed-income portfolios

Having decided how much to allocate to bonds, the next question is the choice of which bonds to buy—government bonds versus corporate and other bonds, short term bonds versus long-term bonds, domestic bonds versus foreign bonds, developed country bonds versus emerging market bonds, and so on.

Negative rates create serious problems for this task of designing the fixed income portfolio. Traditionally, many investors used a passive strategy of tracking a bond market index (either a domestic bond index or a global bond index). Negative rates have led to a situation where these indexes are now dominated by long maturity government bonds (ECB, 2015). The interest rate risk of these bond

indexes is now uncomfortable for many bond market investors.

They are now forced to ask the question whether they are better off with a fixed income portfolio with a different composition that trades off duration risk [8] for credit [9] or currency risk. If the investor shifts from a conventional bond index with a duration of, say, six years (dominated by domestic government bonds) to an unconventional bond portfolio with a duration of only two years (with a large share of corporate bonds, mortgage securities, foreign, and even emerging market government bonds), does the risk actually come down?

In a relatively benign environment, the answer is yes: the drastic reduction in duration risk more than offsets the other risks which are anyway muted in a benign scenario. But in a deflationary scenario, the duration risk is irrelevant (rates will remain negative or go down even further) and the credit risks could be very severe. Again, the question is one of betting on the central banks or betting against them.

3.3 Pension and retirement savings

Negative rates are most frightening when it comes to pension funds and retirement savings. Many pension funds are at a severe risk of being unable to meet their obligations because of the evaporation of returns. For individuals, the question becomes whether they can count on the promised pensions and annuities or whether they should start preparing for possible defaults and start building other pools of savings to see them through the remaining years of their lives [10]. People who are still employed may have to decide if they can actually afford to retire at all or whether they will have to keep working as long as their health permits.

4 Corporate Finance: Working Capital Management and Bank Profitability

4.1 Working capital management

Companies suffer from negative rates when it comes to parking their surplus cash, but they could benefit from low rates when it comes to their own borrowing. On the working capital front, there is a curious phenomenon at work. Banks have so far avoiding charging negative interest rates to their retail depositors, but have shown no such mercy to large corporate clients.

The asymmetry is grounded in the simple fact that currency notes are primarily a household and small business asset; subjecting their deposits to negative rates carries a substantial risk of their shifting to cash to avoid this cost [11].

This creates an opportunity for large businesses to avoid negative rates by passing on their excess cash to their retail or small business customers and suppliers. Even if the supplier offers 30-day payment terms, the large business can choose to pay immediately (or even in advance). This strategy has another big advantage – small business are starved of credit even in a world that is awash with liquidity, and they may be willing to offer better prices or other terms in exchange for prompt payment.

On the receivable front, it makes sense to offer longer payment terms to individuals and small businesses to reduce the surplus cash. In this case, the company, of course, faces the risk that the customer might default. Assuming that the company already had a sound credit risk management system in place, this risk can be substantially mitigated.

Turning to borrowings, negative interest rates in Europe provide two benefits to large businesses: first, very low or even negative cost of funds and second, much greater availability of funds. In terms of cost, some of the biggest companies in the world have seen their borrowing cost go to zero if not lower.

Companies like Sanofi and Unilever have been able to borrow at negative interest rates (yields of -0.05 percent). Several other companies including Royal Dutch Shell, Siemens AG, Johnson & Johnson, General Electric, LVMH, and Philip Morris have seen their debt trade at negative yields in the secondary market. Many issuers who could have issued short-term paper at zero or negative yield have instead chosen to lock in longer term financing with a low yield.

One disadvantage for foreign companies' borrowing in euros is the currency mismatch. Some companies have used the euro borrowings to finance

their European subsidiaries so that the currency risk is irrelevant. Others have used currency swaps to eliminate this risk and at some points of time, these swaps have been so cheap that the fully hedged dollar cost of borrowing has been very attractive.

Even more important than the low cost of funds has been the greater availability of credit. The very large U.S.-based merger deals like Anheuser-Busch InBev and SABMiller megamerger were readily financed by turning to the European markets where investors fleeing negative yielding government bonds have been very receptive to corporate debt. U.S. issuers (so called reverse Yankee bonds) have become significant players in euro-denominated bond markets, and this is likely to continue as the ECB implements its corporate bond buying program.

Foreign issuers have so far benefited only indirectly from ECB corporate bond purchases (investors selling European corporate bonds to the ECB have bought foreign euro-denominated bonds). It is possible that some foreign companies will create eligible European Special Purpose Vehicles to issue bonds that could be sold to the ECB.

4.2 Bank profitability

In traditional banking, much of banks' profits come from interest margin, which is earnings from loans net of funding costs. Theoretically, ignoring income or losses from other sources, if both the lending and the deposit rates reflect a spread on policy rates, and if the spread remains constant, the level of policy rates ought not to matter much.

However, with banks, both in Japan as well as the euro area, not passing on the negative rates to retail customers, prima facie it suggests that banks would get adversely affected. But not all banks rely on deposits as their main source of funding.

If funding costs are not affected, a lower (or negative) lending rate (a) reduces the risk of default by the borrower, which should help improve the loan profile of the banks, meaning lower net losses than otherwise and (b) contributes to higher loan offtake, meaning higher loan volumes and earnings. To what extent, then negative rates adversely/positively impact a banks' profitability is an empirical matter. Whether or not the banks in a region get adversely impacted by negative rates depends on the mechanism of implementation of negative rates, the banks' business model, and reliance on retail deposits as the source of funding [12].

For example, evidence from Sweden suggests that the negative rates have had no material impact on the banks' cost-to-income ratio because Swedish banks depend more on the "wholesale funding"' via capital and swap/derivatives markets, than the retail deposits [13]. On the other hand, banks in other euro area countries have been known to be adversely affected [14]. In the long run, however, such easy credit may lead back to the financial imbalances that caused the crises in the first place [15].

5 Finance Theory

In much of finance theory, bond prices are the fundamental quantities and interest rates are just a convenient tool for computing bond prices. While theory only requires bond prices to be non-negative and not interest rates, intuition around many basic results need to be revisited with negative interest rates.

5.1 Perpetuities

The formula for the present value of a perpetuity $PV = 1/r$ breaks down when the interest rate, r, is negative: it yields the absurd result that the present value is negative. In fact, the present value is infinite. (For the mathematically minded, the present value is the sum of a geometric series which diverges for $r \leq 0$. Interestingly, the formula for a growing perpetuity $PV = 1/(r - g)$ is still valid under the text book assumption that the interest rate r exceeds the growth rate, g. But this requires negative g in a negative rates world. That is why the $PV = 1/r$ formula for the zero growth case fails.

5.2 American versus European Options

It is no longer true as the textbooks claim that an American call option on a non-dividend paying stock would never be exercised prematurely and is therefore the same as a European call. On the same

lines, the opposite textbook claim about put options is now false.

In a positive interest rate world, for a call option premature exercise never happens for two reasons: (i) premature exercise requires early payment of the exercise price and this leads to a loss of interest and (ii) premature exercise destroys the downside protection that the option provides against decline in the asset price in future. In a negative interest rate world, while the second factor continues to hold, the first factor is now reversed—holder would want to pay the exercise price as early as possible to avoid the tax (of negative rates) on cash holdings. Therefore, if the call is sufficiently deeply in the money, the tax on cash holdings can outweigh the downside protection and it may be optimal to exercise the option early.

Similarly, for a put option, the result that a deep out of the money put could be exercised early to realize the cash flow early doesn't hold any more. American puts would never be exercised early. Whether or not the stock pays a dividend, an American put is the same as a European put.

5.3 Bond pricing and risk measures

In the bond markets, bonds are classified into par, premium, and discount bonds depending on whether they trade at, above, or below their par value (or face value). The most important barometer of the bond markets is the par bond yield curve which shows the yields on par bonds – these yields represent the interest that the issuer needs to pay every year if it wishes to borrow now and repay the principal at maturity.

In a world of negative interest rates, par bonds might conceivably disappear: both the Swiss Government and German Government have chosen to sell bonds with low or zero coupons and price them at a premium to par to achieve negative yields. If this trend continues, then in a negative rates world, there will be no par bonds and no discount bonds, and the concept of a par bond yield curve becomes problematic. Over a period of time, probably negative coupon bonds will emerge. Negative interest payments have been observed on bonds with a floating interest rate (instead of a fixed coupon, the bond has a variable interest rate linked to market yields). In Denmark, for example, there have been negative interest payments on some mortgages. As people get used to negative coupons, they may start appearing in fixed-rate bonds as well.

With negative coupons, the standard textbook result that the duration of a bond cannot exceed its maturity is also no longer true. It is also not true that for the same maturity, the zero-coupon bond has the longest duration. For example, a simple calculation shows that a 10-year par bond with a −1 percent coupon and a −1 percent yield has a duration of 10.47 years which exceeds the maturity of 10 years.

6 Modelling Interest Rates at the Zero Lower Bound

There is one important field where interest rates (rather than bond prices) are fundamental, and that is the field of interest rate futures and options where the underlying asset is an interest rate. For pricing these derivatives, the volatility of interest rates needs to be modelled, and here zero or negative interest rates create some problems. The issue relates to how interest rate volatility depends on the level of interest rates.

If rates have been observed to move up and down by 0.5 percent around a level of 3 percent, how much movement is to be expected when the level changes to 6 percent? One school of thought [16] argues that rates would continue to fluctuate ±0.5 percent, and it is then logical to assume that rates follow the normal distribution. An opposing school following the famous Black-Scholes approach [17] argued that a fluctuation of ±0.5 percent around a level of 3 percent was actually a fluctuation of 1/6th of that level. Therefore, when the level shifts to 6 percent, the fluctuation would be ±1 percent to preserve the same proportionality.

It was then convenient to assume that interest rates are log-normally distributed (the logarithm of the interest rate is normally distributed). It is also possible to take a middle ground, for example using the celebrated CIR model [18] which relates the fluctuations to the square root of the level. A doubling of the level from 3 to 6 percent would cause the fluctuation to rise by a factor of $\sqrt{2}$ from 0.5 to 0.71 percent. All of the above models except the first

(normal models with fluctuations independent of the level of rates) have difficulty with zero or negative interest rates. Figure 3 below illustrates how volatility of a lognormal distribution must be accommodated to allow for it to approach the zero lower bound.

In all these models, the volatility becomes zero as interest rates approach zero, and therefore it turns out that mathematically interest rates cannot reach zero let alone become negative. As interest rates started approaching zero, many derivative traders and exchanges have been forced to abandon these models and go back to the normal model (where volatility is independent of the level of rates) which allows negative interest rates.

7 Conclusion

If one is not in the middle of a financial or economic crisis, these are certainly interesting times for financial markets. When the Swedish Riksbank broke the negative interest rate taboo in 2009, it opened doors for negative rate experiments by other central banks in Europe. And the market price of long-term bonds in many of those countries indicates that market participants are indeed comfortable with negative yields.

Negative rates in practice pose interesting set of challenges to all parts of finance. After discussing the need and the limits of negative rates, we have analysed the impact of negative rates on investment decisions, working capital management, and bank profitability. To the extent interest rates are also fundamental to valuation across asset classes, it is also important to understand how to modify existing interest rate models to account for negative rates.

Negative rates also impact how one studies and teaches basic finance, as even some of the most basic relationships need to be revisited when discount factors no longer discount. Not to mention the impact on valuation of more complex assets where the assumed behaviour for interest rates near the zero lower bound can cause large changes in valuation and risk margins for exotic derivative instruments. Our discussion hopefully provides finance practitioners some handle on things as they go about trying to make sense of this brave new world.

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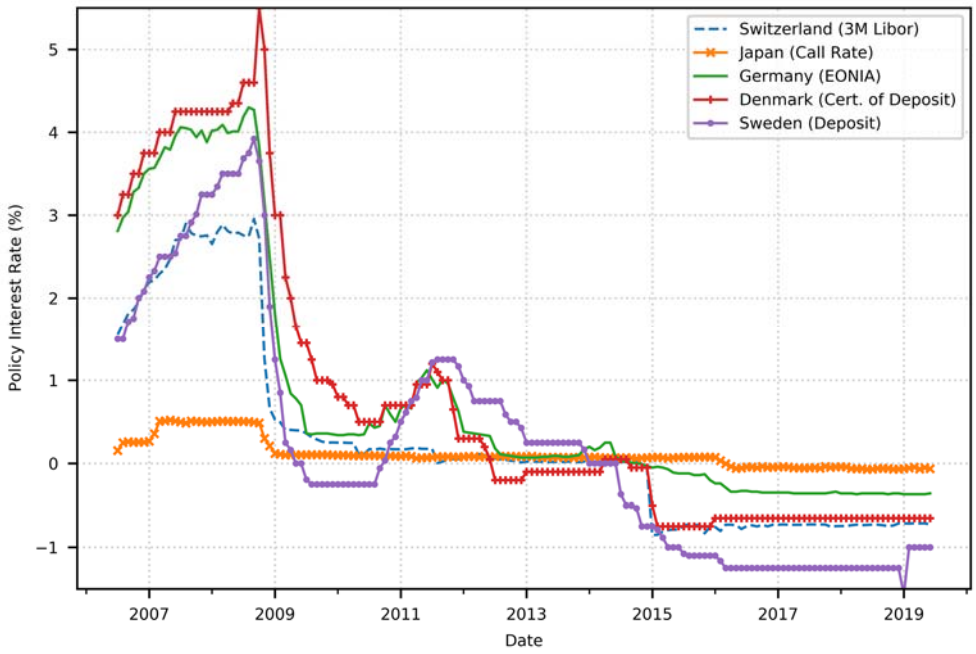
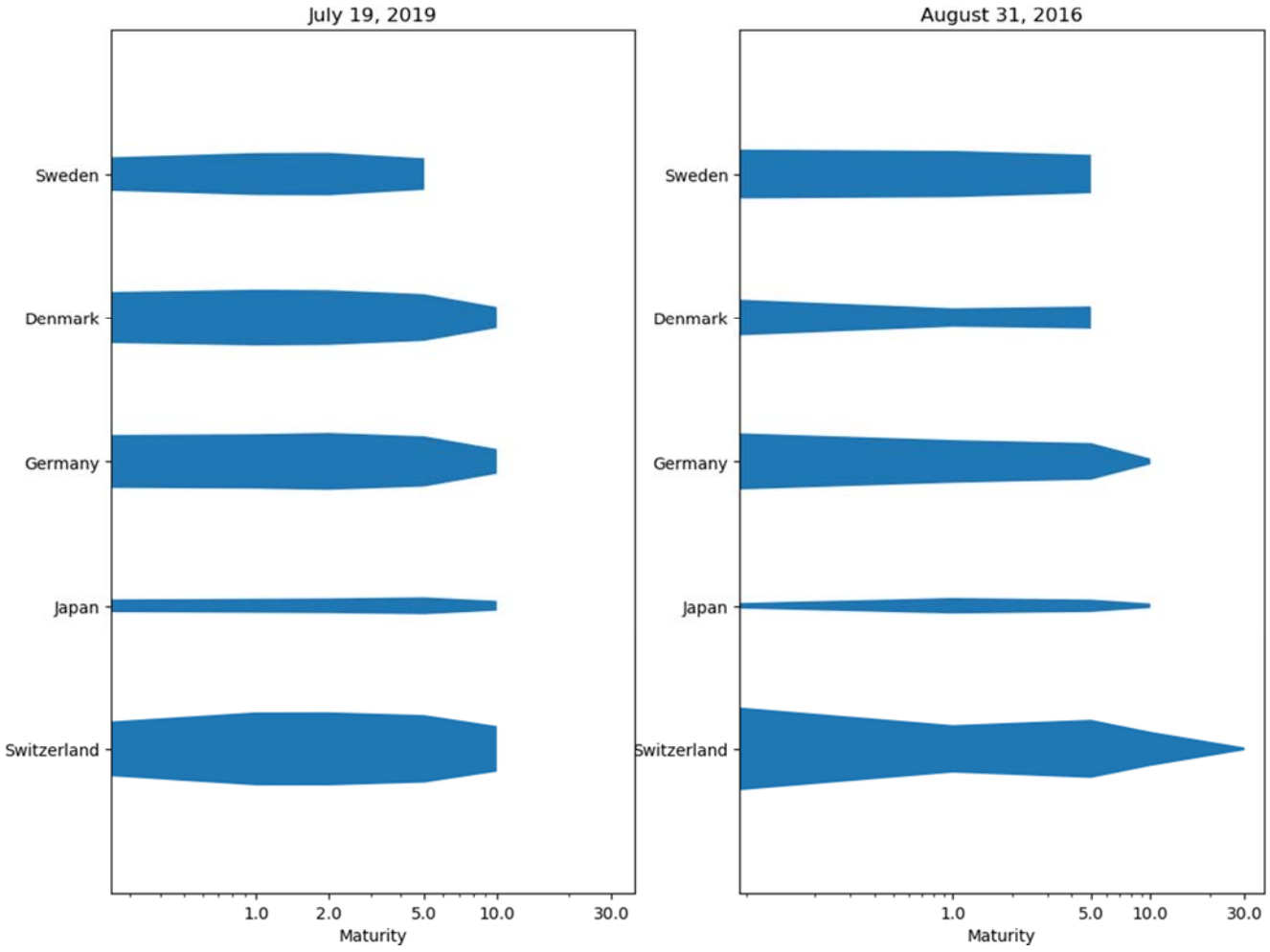
Figure 1
Short-term policy rates in select countries with negative policy rates



Source: Authors' own calculations based on data from respective country central bank websites.

Figure 2
Extent of negative rates (zero-coupon bond yield) over the term structure in select countries with negative policy rates.



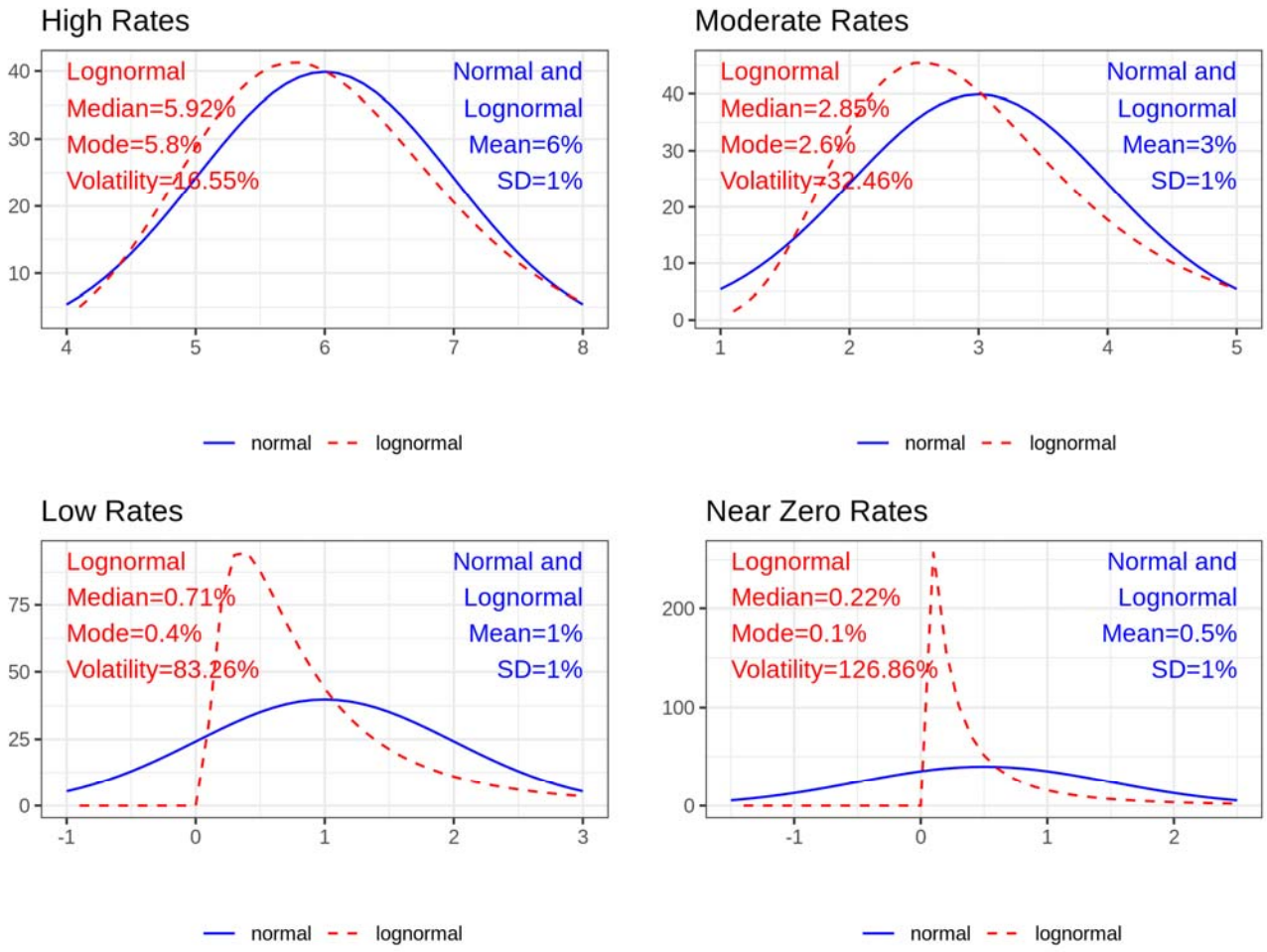
Source: Authors' own calculations based on zero-coupon yields from Bloomberg as on July 19, 2019 and August 31, 2016. The bars indicate how far out in terms of maturity the rate is negative (using log-scale for Maturity). The thickness of the bar at any maturity indicates how negative the rate is at that maturity. For example, in August 2016, the bar for Switzerland was very long, and while it was thick at the left, it tapered off to a narrow line at the right. This image captures the fact that rates were steeply negative at the short-end, but progressively less negative at longer maturities all the way up to 30 years. In July 2019, the bar had become almost uniformly thick but it extended only to 10 years, because the 30 year rate was now marginally positive. On the other hand, on both dates, Japan had a consistently thin bar, meaning small absolute negative rates all the way till 10 year maturity.

Table 1
Forward-forward rates in 2016 and 2019

	1 year 4 year Forward		5 year 5 year Forward	
	July 19, 2019	August 31, 2016	July 19, 2019	August 31, 2016
Germany	-0.682	-0.488	0.008	0.349
Switzerland	-0.920	-0.845	-0.328	-0.143
Japan	-0.245	-0.162	-0.039	0.047
Denmark	-0.630	-0.334	0.053	0.426
Sweden	-0.402	-0.507	0.443	0.711

Source: Authors' own calculations based on data obtained from Bloomberg.

Figure 3
Volatility of a lognormal distribution to accommodate spending time near the zero lower bound at different levels of interest rates



Source: Authors' own calculations