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The Negative Interest Rate Policy Experiment[1]

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Nominal interest rates cannot go negative, or so say the textbooks gathering dust on my bookshelves. Tell that to the European Central Bank (ECB, see Figure 1) and other central banks across Europe that have implemented negative interest rates on banks' excess reserve holdings.[2] This paper surveys the theoretical underpinnings of a Negative Interest Rate Policy (NIRP); the trade-off central banks face in implementing it; and the tentative empirical evidence that assesses its efficacy.

THEORETICAL UNDERSPINNINGS OF NIRP

What exactly is the textbook explanation for the existence of a *zero lower bound* (ZLB) on nominal interest rates? In normal times, a central bank adjusts its policy rate – a short-term risk-free nominal interest rate – in order to stabilize aggregate demand in the economy. When the economy slows, the central bank cuts its policy rate. When the economy really tanks, the central bank can cut its policy rate to zero and no further. This ZLB derives from the existence of a risk-free perfectly liquid asset that carries a zero nominal interest rate – currency. Currency should dominate any asset that pays a negative nominal interest rate.[3]

In practice, several central banks did not even venture to the ZLB during the financial crisis despite a clear need for additional monetary policy stimulus. The ECB, for example, only lowered its deposit facility rate (DFR) – the interest rate paid on reserves – to 0.25 percent during 2009–2011, whereas the Bank of England cut its Bank Rate to 0.5 percent and remained there until 2016 when it briefly cut the rate to 0.25 percent and no further. As a result, economists often refer to the effective lower bound (ELB) rather than the ZLB on nominal interest rates. In short, low positive interest rates appear to raise concerns, not just negative interest rates.

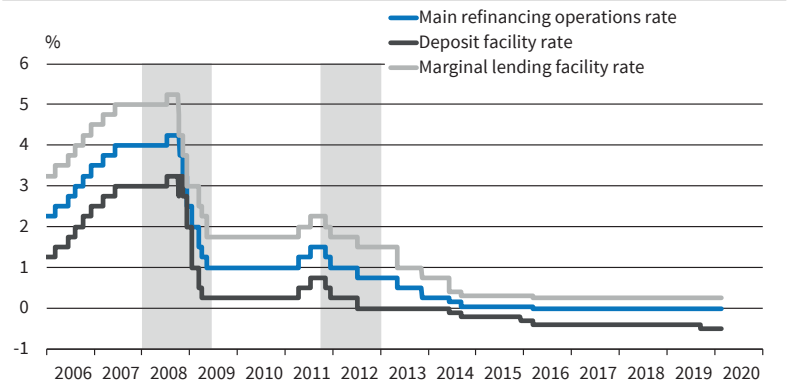
A low interest rate environment generates outcries from the public just as a high interest rate environment does – central banks are rarely popular. That is because changes in interest rates have differential effects on segments of the population. When interest rates are high, borrowers (homeowners with mortgages, for example) are outraged. When interest rates are low, savers (retirees living on the interest from their pensions, for example) are outraged. However, monetary policy is concerned primarily with stabilizing aggregate demand and not these distributional consequences.

An interest rate measures the relative price of consuming today versus consuming in the future. When interest rates are low, consuming today becomes relatively cheaper. This is the basic logic of a central banker. If aggregate demand (households' willingness to consume) is low, unemployment rises. Lowering interest rates can induce households (in aggregate) to increase consumption today and this will prop up aggregate demand and employment. So, if a positive ELB is not to protect savers' income, then what is the rationale?

Rather, central banks are concerned about the banks. To understand why, we need to build a more nuanced picture of how monetary policy works. So far, in this narrative, there has been a single short-term nominal interest rate in the economy set by the central bank. In reality, neither households nor firms save and borrow at this interest rate. In reality, the banking system plays a major role in intermediating funds between savers and borrowers. Suppose, for simplicity, that households save via bank deposits and firms borrow via bank loans. Banks, in this environment, are in the business of 'maturity transformation', taking households' short-term liquid savings and using them to finance long-term illiquid investment projects. A bank earns profits from the spread between the interest rate on its assets

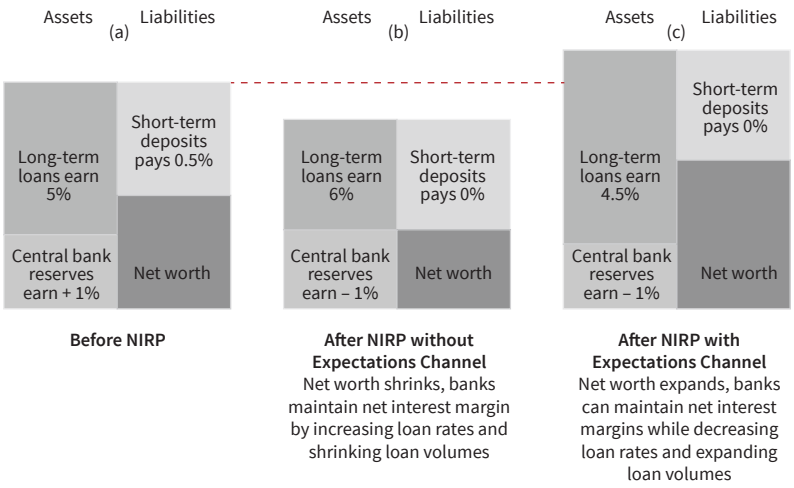
[1] The authors are grateful for excellent research assistance from Yaxin Zheng. Disclaimer: de Groot was a consultant to the ECB in 2019. Haas was an intern at the ECB in 2018. The views expressed in this article are the authors' views alone.
[2] The other economies include Denmark, Sweden, Switzerland, and Japan. Bech and Malkhozov (2016) provide an excellent overview of the technical aspects of how the different central banks have implemented negative interest rate policies.
[3] Buiter (2009) has suggested overcoming the ZLB by abolishing cash or taxing cash holdings.

Figure 1
ECB Policy Rates



Source: European Central Bank. © ifo Institute

Figure 2
Bank Balance Sheets before and after NIRP



Before NIRP

After NIRP without Expectations Channel
Net worth shrinks, banks maintain net interest margin by increasing loan rates and shrinking loan volumes

After NIRP with Expectations Channel
Net worth expands, banks can maintain net interest margins while decreasing loan rates and expanding loan volumes

Note: Balance sheets not drawn to scale. Before NIRP: Suppose the following quantity of loans, L=7, reserves, R=3, deposits, D=5. The net interest margin (NIM) is 3.55%. After NIRP w/o Exp. Channel: NIM is maintained if L=5.6. NIRP w/ Exp. Channel: NIM is maintained if L=14.4.
Source: Authors' own compilation.

(loans to firms) and the interest rate it pays on its liabilities (household deposits).[4]

In this setting, the central bank interacts with banks in the banking system and the banks interact with households and firms. Figure 2 provides a stylized view of a bank's balance sheet. Some of the bank's assets are reserves held at the central bank. These reserves earn the central bank policy rate (or short-term nominal risk-free interest rate). In this example, the bank earns a 5 percent return on loans, a 1 percent return on central bank reserves, and pays a 0.5 percent return on deposits.

Since bank reserves earn a lower return than loans, why do banks hold reserves? Banks face liquidity risk – the risk that there is an unexpected outflow in deposits – and a bank needs to insure itself against this risk since it is costly to liquidate long-term loans. Banks can hold reserves, which are liquid assets, for this purpose. However, banks need not hold reserves in excess of regulatory requirements. A bank with liquidity needs could also borrow funds from another bank so long as the interbank market is working well. The 2007/08 panic saw a freezing up of interbank markets. Demand for excess reserves increased rapidly during that period since it was a means of ensuring liquidity without facing counterparty risk – reserves provide insurance against the insolvency of other financial institutions. Banks in the euro area continue to hold a large quantity of excess reserves amounting to around 20 percent of total deposits in the banking system (de Groot and Haas 2019).

In a frictionless financial system, we can expect all short-term risk-free interest rates to move one-for-one with a change in the policy rate. However, consider the example in Figure 2 in which the central bank cuts the policy rate on reserves from + 1 percent to − 1 percent. As argued above, banks find it difficult to reduce deposit rates below zero because of the existence of cash.[5,6] All else equal, the inability to fully pass on a cut in the policy rate to depositors would result in a fall in banks' net interest margins (NIM, see Figure 2 (b)).[7]

In a frictionless financial system, the profitability of the banking system would be irrelevant for outcomes in credit markets and the spread between the interest rate on risk-free loans (5 percent in the example) and on deposits (0.5 percent) would disappear. Any such spread would represent an arbitrage opportunity. Banks could exploit this arbitrage opportunity by leveraging up, drawing in more deposits (by increasing the deposit rate), and issuing more long-term loans (by decreasing the loan rate). In reality, banks face financial constraints, which explains the existence of such a spread. Concerns such as moral hazard limit banks' ability to leverage. Bank equity (net worth) protects depositors from loan losses and as such, depositors will be unwilling to lend to a bank that is highly leveraged.

If net worth in the banking system falls, depositors become reluctant to supply deposits and banks have to curtail lending activities, driving up the spread between saving and lending rates. As a result, profitability of the banking system is important for the process of credit creation in the economy. When banks struggle, as evidenced during the financial panic of 2007/08, the broader economy also suffers.

Thus, even before we discuss the relationship between negative rates and bank profitability, there is an argument that low rates can hurt bank profitability. The argument goes as follows: during 2008/09, the ECB sharply cut its (short-term) policy

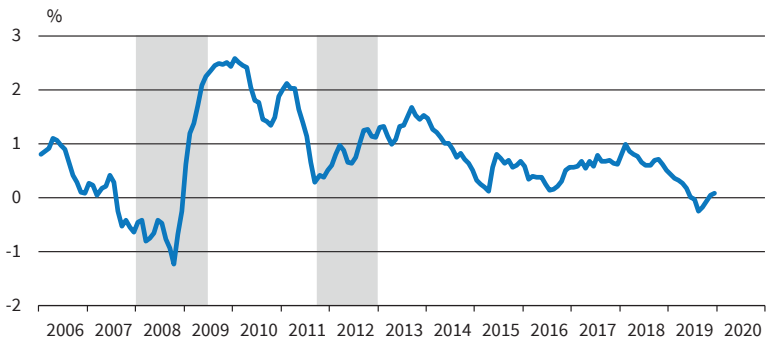
[4] For simplicity in this example, we are assuming that loans are risk-free.

[5] For simplicity in this example, we are assuming that banks' demand for reserves is sufficiently price-inelastic such that the change in the quantity of reserves demanded as a share of total deposits remains broadly unchanged.

[6] Holding cash involves storage costs. Thus, households may be willing to accept a marginally negative interest rate on deposits. Moreover, corporations may be willing to accept a more negative deposit rate since the storage cost for large cash holdings is likely to be higher. This is confirmed empirically by Altavilla et al. (2019). However, the evidence from Heider et al. (2019), among others, suggests that the pass-through of negative policy rates to deposit rates has been particularly slow. See Rognlie (2016) for a theoretical model that incorporates storage costs.

[7] The net interest margin is a measure of the difference in interest earned on assets and interest paid on liabilities, relative to assets. In the example of Figure 2 (a), NIM = (7x5% + 3x1% − 5x0.5%)/10 = 3.55%. Without a change in balance sheet composition, if the interest rate on reserves falls to − 1% and the interest rate on deposits falls to 0%, then the bank's NIM falls to 3.20%.

Figure 3
The German Yield Curve Has Flattened[a]



[a] German ten year government bond yield minus three month interbank rate.
Source: OECD.

rate, while longer-term rates remained relatively stable. This created a steepening of the yield curve (Figure 3). Since banks engage in maturity transformation, this proxies a rise in bank profitability. However, over time, as short-term rates remained near zero, long-term rates also began to slide downwards, flattening the yield curve and potentially reducing banks' profits. Notice that this argument is not about low interest rates per se but rather the difference between short- and long-term rates.

Nevertheless, putting this concern aside for now, estimates from Taylor-type rules, which make the policy rate an increasing function of inflation (relative to target) and the output gap, suggest that policy rates should have been well into negative territory after 2009, if not for the ELB. In that sense, had short-term rates been able to fall into negative territory, this would have allowed a further steepening of the yield curve and provided additional support for banks.

THE BANK BALANCE SHEET CHANNEL AND NIRP

Several papers, including Brunnermeier and Koby (2018); de Groot and Haas (2019); Eggertsson et al. (2019); and Sims and Wu (2019), study the bank balance sheet channel in the context of negative interest rates.[8] When the policy rate turns negative, banks cannot pass this rate on to depositors and the deposit rate becomes stuck at zero. Banks are now earning a negative interest rate on a portion of their assets funded by deposits. Effectively, the central bank is taxing banks for holding reserves. This causes a fall in banks' net interest margin, so profits fall and net worth falls. A fall in net worth forces banks to curtail lending. In equilibrium, lending rates rise, credit shrinks, lowering consumption demand and investment. This is the fear: that negative interest rates are counterproductive – they don't lower deposit rates, they raise lending rates and economic activity contracts.

[8] See also Glover (2019) and Porcellacchia (2019) for related theoretical work.

What might be missing from this narrative? First, we need to inspect our assumption about reserves. Are reserves fixed? Could banks hold less reserves if they wanted to? On the one hand, yes, reserves are simply unproductive deposits. However, we have argued that banks are already financially constrained and up against their leverage constraint. While the central bank has control over the aggregate quantity of reserves in the banking system in euro terms, the reserve-to-asset ratio is determined within the banking system. Thus, the observed increase in excess reserves as a fraction of deposits within the banking sector reflects a demand for liquidity on the side of the banking system. The extent to which banks wish to hold a smaller fraction of reserves because of negative interest rates depends on the price elasticity of that demand. Empirically at least, it is not clear that this demand for liquidity is particularly elastic. Thus, banks experience negative interest rates as a downward force on net interest margins and not as a spur for further loan creation.

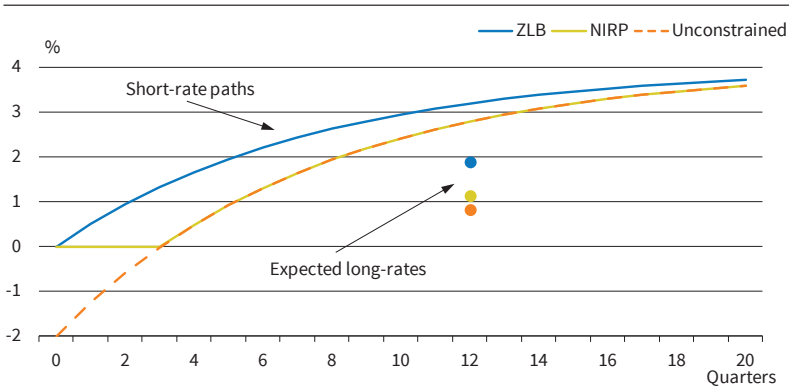
THE EXPECTATIONS CHANNEL AND NIRP

However, the prediction that NIRPs are contractionary runs contrary to most of the empirical evidence. A second important channel of monetary policy exists – the expectations (or signaling) channel, which we study in de Groot and Haas (2019). Much of the theoretical literature has overlooked this channel, but it is potentially very potent and reconciles the existing empirical evidence.

Even though in the environment described above, households save via short-term interest rates, future interest rates determine their consumption decisions as well. Suppose policy rates evolve as follows: i) In normal times, the policy rate is 4 percent. ii) If the central bank lowers the policy rate today, households expect that the central bank will increase the policy rate only slowly back to its normal level. This behavior is termed central bank *inertia* or *smoothing* in the monetary policy literature and is empirically well documented.

For concreteness, suppose that central bank policy-rate changes have a half-life of around five quarters and that the central bank lowers the interest rate to 0 percent. Then households expect the interest rate to revert along the blue path in the Figure 4. Using the expectations hypothesis, the average of these short-term interest rates over the next 12 quarters equals 1.9 percent (blue dot). Thus, changes in

Figure 4
Expectations Channel



Source: Authors' calculation.

policy change expectations about the future and are factored into households' and firms' decisions.

Suppose instead, the central bank calculates that it needs to lower the three-year interest rate today to 0.8 percent in order to meet its inflation target. Lowering interest rates to 0 percent, in this scenario, would not be sufficient. If, instead, the central bank was unconstrained by the ZLB, it could simply set today's short rate at − 2 percent in order to achieve this long-term interest rate objective (orange dotted line).

Alternatively, the central bank might like to promise to maintain interest rates at 0 percent for an extended period. However, households may not deem this credible. Instead, the central bank can signal its intention by setting the policy (reserve) rate to − 2 percent while banks maintain deposit rates at 0 percent. This has the same effect as keeping deposit rates at 0 percent for the next three quarters (yellow line). This lowers the long rate (yellow dot) to 1.1 percent, close to its objective. In this way, the central bank is using negative interest rates to *signal* lower-for-longer deposit rates in an environment in which it cannot commit to maintaining both policy and deposits rates at zero. This is the rationale for negative interest rates explored in de Groot and Haas (2019).

Okay, but what of the banks? Will the banks not suffer via the balance sheet channel identified before? The theory and evidence suggest not. Banks' balance sheet health (and net worth) is not determined solely by net interest margins. In fact, net interest margins can shrink and balance sheet health can simultaneously improve. Consider what happens when consumption demand increases via the signaling channel identified above. The economy gets stronger, unemployment prospects increase, and thus the default probability on banks' assets falls. As this risk recedes, banks' assets become more valuable. This is the scenario pictured in Figure 2 (c). As a result, bank net worth rises and leverage falls, allowing for an expansion in lending and a fall in lending rates.

Since the bank lending and signaling channels work in opposite directions, the effectiveness of NIRPs is ultimately a quantitative question. In de Groot and Haas (2019), using a carefully calibrated quantitative model, we find that the signaling channel dominates and NIRPs are effective. However, the strength depends on the quantity of reserves in the banking system, the expected duration of the ZLB period, and central bank inertia. The theory predicts that NIRPs are more effective when the ratio of excess reserves is low, the expected duration of the ZLB is short, and the central bank adjust policy more gradually.

EMPIRICAL EVIDENCE

Our explanation of the channels through which negative interest rates work raises several hypotheses that need to be tested. The empirical evidence, however, remains in its infancy. In part, this is because standard methods of identifying monetary policy shocks do not work. First, there is not yet a sufficient time-series of data points. Second, negative interest rates were often introduced alongside a range of other monetary policy measures, making even high-frequency identification methods problematic. Instead, the majority of the empirical literature has sought to exploit cross-sectional variation by analyzing bank profitability making use of, for example, difference-in-difference estimation techniques. While this micro-level evidence helps to highlight the transmission channels, it does not provide an accurate gauge of the macroeconomic effectiveness of NIRPs.

Nevertheless, Ampudia and Van den Heuvel (2018) find that a 25 basis point surprise rate cut will lower bank equity values by 2 percent in the period of NIRPs. However, consistent with the signaling channel, the effect of a long-term rate surprise operates in the conventional direction. A 25 basis point policy-induced reduction in the long-term rate increases bank stock prices by about 3 percent. Heider et al. (2019) study bank risk taking and find that banks with more deposits finance riskier firms when rates become negative. Moreover, they find that banks that are highly reliant on deposit financing are more likely to reduce loan volumes. Boungou (2019), in contrast, finds that a 25 basis point decrease in the policy rate leads to a 10 basis point reduction in net interest margins, a reduction in risk-taking, but an improvement in banks' creditworthiness.

Lopez et al. (2018) study both Europe and Japan and find that bank profitability has, thus far, been

unaffected by NIRPs. In particular, consistent with the signaling theory, they find that losses in terms of net interest income are compensated for by non-interest income such as capital gains on securities. As a result, banks that rely less on deposits perform better under NIRPs than banks heavily reliant on deposit funding. Scheiber et al. (2016) study Denmark, Sweden, and Switzerland and conclude that NIRPs have not resulted in a significant reduction of bank profitability and particularly of net interest income. Madaschi et al. (2017) also study Denmark and Sweden. They conclude that net interest income margins have remained broadly stable in Sweden and have declined only marginally in Denmark. Basten and Mariathasan (2018) study Switzerland and also document evidence of increased risk-taking.[9]

What can we conclude from this mixed evidence? Have banks actually been reluctant to pass on negative interest rates to its customers? Initial evidence suggested the answer to this question was yes. However, more recent evidence from Altavilla et al. (2019), for example, suggests that, over time, it appears that banks are increasingly setting negative interest rates on deposits. This suggests that the effectiveness of negative interest rates is likely to be time-varying and that as deposit rates fall, NIRPs act more like conventional monetary policy.

Have bank profits fallen as a result of negative interest rates? The empirical evidence summarized above is mixed. On balance, the evidence suggests that net interest margins have been compressed but along other non-interest dimensions, like capital gains, bank profitability has risen. Overall, the effects on bank profitability appear to have been modest. Have there been side-effects of negative interest rate policies? The literature provides suggestive empirical evidence that risk-taking by banks has increased. However, the evidence remains limited and not all the studies agree.

CONCLUSION

The effectiveness of negative interest rates remains open for debate. In fact, the effectiveness of standard monetary policy actions continues to be keenly debated amongst economists and, in this area we have a wealth of data stretching back decades and across many countries. Like with all policy actions, we do not have a clean laboratory in which to study monetary policy. Thus, identifying exogenous changes in monetary policy is difficult. Identifying exogenous changes in policy during recent negative interest rate episodes is even more difficult. This issue confronts all the empirical papers surveyed in this study. The ECB entered into its NIRP at the same time as introducing multiple other unconventional policy measures. Disentangling these effects is problematic.

Nevertheless, theory tells us the upper bound of the effectiveness of NIRPs is the effectiveness of standard policy rate changes. At the other extreme, it is hard to conclude from the evidence that NIRPs have had catastrophic economic consequences. They do not appear to have created clear financial stability issues, nor contributed to a marked slowdown in economic activity. Nor has there been a sharp move into currency holding.

In clinical trial research, experiments are halted when early results show no justification for exposing human subjects to additional potential risk by continuing the trial. The NIRP experiment has thus far been conducted in gradual steps. On balance, the benefits of each step down into negative territory have been modest but the risks also seem manageable. Finally, with aggregate demand in the euro area remaining weak and global demand slowing, we would conclude that it is beneficial for the euro area that the ECB continues to explore the depths to which policy rates can be lowered in negative territory in order to generate additional monetary stimulus.

[9] For evidence from Japan, see Yoshino and Miyamoto (2017); Yoshino et al. (2017); and Inoue et al. (2019).

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