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AN IMPACT ASSESSMENT OF NEGATIVE INTEREST RATES OF CENTRAL BANKS

Linas Jurkšas*
Vilnius University, Lithuania

Abstract. *The central bank community has been split into those who started to employ negative interest rates (NIR) and those who do not intend to do so, irrespective of the similarity of the economic situation. Moreover, while five central banks have applied negative policy rates from 2012, the launch time, scope and motives behind differ significantly. The fact that central banks have simultaneously pursued NIR at a time when the global financial system is not in a crisis is unprecedented and is a consequence of several fundamental and mutual factors. So, the purpose of this paper is to find out the motivation behind employing negative policy rates and assess how NIR affect different economic sectors. The statistical analysis reveals that the overall outcome is highly controversial, depending on the weight assigned to each economic sector as well as to short- and long-term goals. On the one hand, NIR lead to an overall positive impact on aggregate consumption, increased well-being of net borrower, investing NFCs, indebted governments and even financial institutions in the short run. On the other hand, savers and banks with high excess reserves and less room to reduce net interest margins are the most negatively affected. The impulse-response functions of created vector autoregression model for the euro area confirms these results: an interest rate reduction shock decreased borrowing and deposit rates, net interest margins but positively affected confidence, bond and equity prices, leading to somewhat higher expectations of economic growth and inflation in the longer term. While the lower bound of NIR remains uncrossed, further rate cuts in the negative territory or keeping them for a prolonged period of time might alter negative externalities. If expectations start looming over the material policy change or materialization of financial systematic vulnerabilities, positive effects of NIR could become more muted in the longer term.*

Key words*: negative interest rates, central banks, policy rates, lower bound, financial institutions.*

1. Introduction

Although early mathematicians thought that the idea of negative numbers was absurd, five central banks from Europe and Japan have moved their policy rates into negative territory. Danmarks Nationalbank (DNB), European Central Bank (ECB), Sveriges Riksbank (SRB), the Swiss National Bank (SNB) and the Bank of Japan (BoJ) have been charging NIR on deposited excess reserves. While real interest rates have been a norm rather than an exception in some countries (notably, Germany and Japan), nominal policy rates are still novel. For instance, negative short-term government bond yields

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* *Corresponding author:*
Faculty of Economics, Vilnius University, Sauletekio av. 9, LT-10222 Vilnius, Lithuania.
E-mail: l.jurksas@gmail.com

(that highly correlate with policy rates) have been an extremely rare phenomenon: US rates were never negative even during the Great Depression, while during the height of the recent global financial crisis in 2008, some US Treasury bill yields only very briefly fell below zero (Wold Bank, 2015).

The motivation for employing NIR differ somewhat across central banks, but it is essentially a result of a long-lasting trend of decreasing growth and inflation prospects. However, other central banks that have near zero policy rates (e.g., FED, Bank of England) still avoid introducing NIR, mainly stating concerns of the viability of the banks. So, it is very important to understand why central banks that face similar fundamental circumstances undertake different decisions and, ultimately, how these decisions affect real economy and the well-being of residents. This is of particular importance in the current economic environment as many countries suffer from low economic growth and inflation that implies policy rates should be set near the zero lower bound or even below it.

The main purpose of this paper is to ascertain the motivation behind the introduction of negative policy rates and assess what impact NIR have on different economic sectors. The sectors that are mostly discussed of being affected by NIR are money markets, households, non-financial corporations, financial institutions, governments and asset markets. The impact on these sectors ultimately affects the economic growth and inflation, i.e., the main determinants of central banks' goal function. However, various exemptions weaken the direct effect of negative policy rates. Also, while previous studies mainly examined the effects of positive interest rates, this paper puts more focus on the short- and long-term impacts of low or even negative rates on different economic sectors.

The use of econometrical models in analyzing NIR effects is seldom used mainly due to the short history on NIR and complexity in determining causal links between various sectors. Due to this reason, a generalization of the findings of other authors' papers as well as statistical and graphical analyses are employed in this paper. This analysis is based on the data of the Statistical Data Warehouse, Thomson Reuters, IMF Financial Soundness Indicator and other sources for the five countries (whenever available) that introduced NIR. Also, the impulse-response functions of the vector autoregression model for the euro area from 2000 to March 2017 were performed. This analysis helps to examine the effects of the interest rate reduction shock, which is a close proxy of an NIR shock, and cross-check the results of statistical and graphical analysis. The results of this broad-based analysis are important to both the academic society and policy makers as the history of NIR is quite short and full effects will materialize only gradually in the longer term.

Without the introduction and conclusions, this paper consists of four main parts: the examination and comparison of the central banks' rationale to introduce negative policy rates; a literature review of the fundamental reasons behind decreasing and even intro-

ducing negative rates; the statistical and graphical analysis and a discussion of the effects of NIR on different economic sectors; the econometrical analysis of interest rate reduction shock effects in the euro area.

2. Central Banks and Their Motives for Employing NIR

During the period between 2012 and 2015, five central banks began charging NIR on deposited excess reserves (see Fig. No. 1). Earlier episodes of negative deposit rates in Switzerland in 1972 or Sweden in 2009-2010 were applied to only a small fraction of deposits, so it did not have any significant and long-lasting effects.

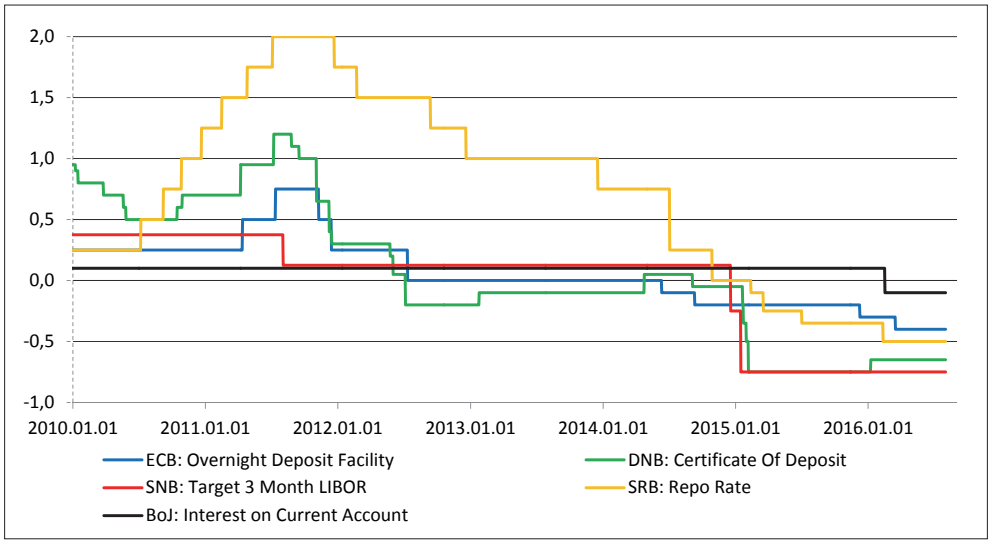

FIG. No. 1**. Policy rates from 2010, %**

Source: author's calculations based on the data of Thomson Reuters.

The motivations behind the decisions vary somewhat across jurisdictions, leading to differences in policy implementation (see Table No. 1). The euro area is the largest region to introduce a negative policy rate and the motivation of the ECB was a persistent risk of deflationary and weak recovery, excessive risk aversion and concentration of liquidity surplus in core banks. Due to the sovereign debt crisis of the euro area in 2012 and the ECB easing measures (including NIR), central banks from some smaller European countries (SNB, SRB, DNB) began feeling pressure from markets to appreciate their exchange rates and suffered from an increasing deflationary risk. For instance, the DNB's announcement of its interest rate reduction at 4.00 p.m. on 5 July 2012 followed the ECB interest rate reduction at 1.45 p.m. (DNB, 2012). BoJ introduced negative policy rates only from the start of 2016, motivating its decision by a persistently low inflation and yen appreciation in the face of an increasing search for safe heaven.

TABLE No 1. **The dates, decisions, exemptions and motivations of centrals banks to introduce NIR**

Central bank	Date and action taken	Exemptions	Reasons
SNB	1972 onward: penalty charge of 2% applied to the increase in CHF deposits from non-residents (in 1978 increased to 10%).		To discourage capital inflows, particularly from oil-exporting countries.
	December 2014 onward: rate on sight deposits at the SNB lowered in 2 steps to -0.75% (and, in January 2015, the abandoned franc peg with the euro that was introduced in 2011).	Negative interest levied on sight deposit account balances exceeding a determined threshold to each individual account holder.	To lower the upward pressure on the franc so as to stabilize price developments and support economic activity, as well as to prevent the SNB balance sheet from further unprecedented expansion.
SRB	July 2009 (till September 2010): deposit rate cut to -0.25%.	The range of deposits subject to NIR was very small and banks could buy debt certificates issued by SRB.	Deep economic downturn.
	July 2014 onward: deposit rate lowered to -0.5 %. Beginning in February 2015, the repo rate was lowered in 4 steps to -0.5%, bringing the deposit rate to -1.25%.	SRB conducts weekly liquidity-absorbing operations by issuing SRB Certificates.	Persistently low inflation as well as the prevention of SEK appreciation.
DNB	July 2012 (till April 2014): Certificates of deposit rate lowered to -0.2%.	Only reserves beyond a predetermined limit are converted into certificates of deposits with negative rates.	To discourage capital flows that persisted already from 2010 due to upward pressure on the krone.
	September 2014 onward: Certificates of deposit rate cut in 5 steps to -0.75% (in January 2016 – increased to -0.65%).	Reserves beyond pre-determined limit are converted into certificates of deposit with NIR.	To manage upward pressure on the krone and defend the ERM II peg (mostly a consequence of the rate reduction and other measures of the ECB and SNB).
ECB	June 2014 onward: lowered the Deposit Facility Rate to -0.4% in 4 steps.	Average reserve holdings in excess of the minimum reserve requirements.	Persistently low inflation, weak recovery, excessive risk aversion and concentration of liquidity surplus in core banks.
BoJ	January 2016: lowered the interest rate applied to current accounts to -0.1%.	Outstanding balance of each financial institution's current account at the Bank are divided into three tiers, to one of them a negative rate is applied.	Persistently low inflation.

Source: prepared by the author on the basis of the information provided by the central banks (SNB, 2013; SNB, 2015; SRB, 2009; SRB, 2016; DNB, 2012; DNB, 2016; ECB, 2015; BoJ, 2016).

However, even though a couple of banks (SRB, SNB) have lowered deposit rates to lower than -1%, the effective "tax", due to various exemptions, can be much lower. For instance, BoJ lowered the interest rate applied to current accounts to -0.1%, but institutions that have such accounts at BoJ are on average paying almost nothing. As a result, the effects of negative rates are weakened due to these exemptions.

Still other central banks that have a near-zero policy interest rate avoid introducing NIR due to several reasons. According to BoE (2013), lower interest rate margins might reduce the banks' profitability and capital adequacy. As quantitative easing and other measures initiated after the financial crisis caused upward pressure on the excess reserves, the charges of these reserves may further reduce banks' profitability. Moreover, if negative policy rates were perceived to be long-lived, banks might decide to convert a part of their reserves into cash or even raise lending rates. Yellen (2013) added that FED had discussed the possibility of lowering interest rates, but the closer the rate is to (or even below) zero, the bigger the risk of disruption to the money markets that help fund banks. Due to these consequences, the transmission of NIR to the real economy may be more muted than normal.

3. Literature Review: the Fundamental Reasons of Low and Even Negative Interest Rates

In advanced economies, central banks have been mostly lowering nominal policy rates for more than 3 decades (though with some notable exceptions during the late 80s or the start of this century) due to certain secular forces behind interest rates. According to Constancio (2016), four main components – the expected inflation over the lifespan of the asset, inflation premia, real term premia and the expected path of short-term real interest rate – contributed to the decline of nominal long-term interest rates. The decline of the first two components can be attributed to a successful monetary policy of the central banks, possibly linked to the adoption of inflation targeting in the 1990s, though inflation expectations fell even below the target rate in the last two years (Haldane, 2015). There are several possible reasons of the decline of the real term premium: an increased demand for safe assets at the global level due the desire of emerging markets to build international reserves for precautionary reasons after the Asian crisis, demographics, new liquidity regulation for banks etc. (Constancio, 2016).

Nevertheless, the decline of nominal rates mostly follows the trend of real rates. Broadly speaking, central banks use policy interest rates to achieve, over the medium term, a level of real interest rates that is consistent with a rate of inflation in line with policy objectives and a level of economic activity close to its full potential (World Bank, 2015). When inflation was high in the past, it was not unusual for real (inflation-adjusted) interest rates to be negative ex post in some countries (Labonte, 2016). Negative real rates of interest on deposits have been the norm rather than the exception in Germany in the recent decades (Coeure, 2016). In that sense, negative rates are not novel; what is novel is for the nominal interest rates to be negative.

Importantly, real rates appear to have fallen similarly among advanced and emerging economies, so the forces driving this decline may be global in nature (Rachel, Smith 2015). For instance, Haldane (2015) states that the explanations for this secular fall in global real rates include excess savings in the East, deficient investment in the West, worsening demographic trends and rising inequality. IMF (2014) mentions 3 main factors: a steady increase in income growth in emerging market economies, rapid reserve accumulation in some emerging market economies and a sharp and persistent decline in investment rates in advanced economies since the global financial crisis. Constancio (2016) argues that real interest rates are mostly linked to the dynamics of potential output that can further be described by the relation of productivity and population growth with savings behavior – studies show that total factor productivity and population growth have been slowing in advanced economies for decades, while the savings have been increasing. Rachel and Smith (2015) identified 5 factors that account for around 310 out of 450 overall basis points fall of long-term real interest rates over the past 30 years and none of them are likely to reverse quickly: a lower trend growth (100 basis points); worsening demographic trends (90 basis points); low investment rates due to the falling price of capital goods (50 basis points); rising inequality (45 basis points); savings gluts in emerging markets (25 basis points).

In summary, there are five most cited explanations why real and, as a result, nominal interest rates have fallen. First, a continued decline in global trend growth reduces spending (and thus increases saving) at any given level of interest rates (Summers, 2013). In particular, the 2008-2009 financial crisis has triggered a wider reassessment of growth prospects and provoked a pessimistic attitude regarding the future. Second, the aging and declining pace of population growth (already in a decrease from 1975) further reduce spending and compress investment demand. For instance, populations from regions that experience low or even negative interest rates, e.g., Japan and the most of Europe, have been growing at dismal rates for more than two decades and are projected to decline further (United Nations, 2015). Third, rising inequality implies a higher saving rate as richer individuals tend to save more, while lower-income households may be unable to invest sufficiently towards education, resulting in less human capital accumulation. Fourth, according to the saving glut theory, the increase of the global supply of savings is a long-lasting phenomenon that has not been matched by a corresponding rise in desired investment, especially in the emerging markets (Bernanke, 2005). Also, China and some other emerging countries intend to rebalance their economies from exports toward domestic demand that will further increase the savings glut. Fifth, an investment-to-GDP ratio in advanced economies has showed a marked decline due to a reduced investment profitability and lower growth of public investment (IMF, 2014). All these dynamics lead to the decline of investment and the increase of saving, and, as a result, to even negative rates in the regions that are mostly affected by these trends.

As low and even negative rates are the result of real economy developments and global factors, monetary policy is therefore part of the solution and not part of the prob-

lem (Constancio, 2016). Coeure (2016) adds that a failure to take into account the downward trend in real equilibrium interest rates would have resulted in downward pressure on inflation and activity, pushing real interest rates up and driving the economy further away from full employment. If the shock of negative policy rates will attain the main goals, i.e., a higher inflation and economic growth as well as the prevention of currency appreciation, central banks, due to possible negative externalities, will feel the pressure to abolish the "experiment" of NIR.

It is important to note that the current cyclical recovery lasts for more than seven years in most of the advanced economies, so the next recession might materialize sooner or later. In order to have the possibility to use the most powerful monetary policy instrument at hand, i.e., to significantly decrease interest rates and thus stimulate real economy, central banks seek to attain higher rates before the next economic recession looms. Also, monetary policy makers are afraid that rates that are "too low for too long" might cause excess risk taking that often leads to the build-up of systematic vulnerabilities in financial institutions and markets in the long-term. This implies that central banks do not favor having NIR for a prolonged period of time. Notwithstanding this, persisting trends of underlying factors imply that interest rates will remain negative or at least very low for quite some time, meaning that various economic sectors will feel the effects of NIR and will have to adapt both in the short- and long-term.

4. Statistical Analysis of NIR Effects on Different Economic Sectors

Central banks that introduce NIR hope to achieve their stated goals through various transmission channels, such as the money market interest rate, expectations and other channels. In the central banks' opinion, this transmission is almost identical as in a case with lowering the positive interest rate. According to Praet (2016), the implications of the ECB rate cuts to negative levels were similar to those of equally-sized rate cuts taking place in positive territory. NIR should induce a decline in short-term money market rates, which via financial market arbitrage transmits along the yield curve and to a wide range of asset classes. The resultant loosening in financial conditions induces firms and households to bring forward consumption and investment decisions. This intertemporal substitution from future to current spending should subsequently support the cyclical recovery. However, in practice, the effects of a negative interest rate can be quite different than encountering positive rates and may pose additional risks.

- **Money Market and Longer Term Rates**

The starting point to analyze the transmission of policy rates to real economy is by determining the pass-through to the money market and longer term rates. The transmission from NIR to money market rates occurred in all five countries that introduced NIR, though in different scale (see FIG. No. 1 in the Appendix). Short term money market rates remained close to policy rates in Switzerland and Sweden, but are higher in the euro area and,

especially, in Japan (by 10 bps) and Denmark (by 20 bps), possibly due to the exemptions applied to charges on excess reserves. These results are in line with the results of other authors (e.g., Bech, Malkhozov, 2016) – modestly negative policy rates have transmitted to short term money market rates in very much the same way as positive rates are, in line with the notion that the effective lower bound on policy interest rates can be lower than zero.

The transmission of negative policy rates to longer-term rates, e.g., sovereign yields, is more complicated. The belief shared by investors that central banks would not lower policy rates to negative territory creates the monetary tightening bias that arises when market expectations on future interest rates are truncated by a perceived lower bound – this drives a wedge between actual market rates and the rate path that investors consider most likely (Praet, 2016). What is more, NIR helped to mitigate the bias of these expectations of a zero-lower bound – yield curves have become flatter in all five countries (see FIG. No. 1 in the Appendix). However, market rates may be affected by other measures of the central bank or even the computation methods of benchmark rates (Jurkšas, 2016). It is also important to note that very low or even negative yields might lead to a fundamental overvaluation of sovereign bonds, thus increasing the risk of market reversal that would have a negative spill-over effect to other markets and bond holders.

- **Households**

NIR had mostly redistributional effects on purchasing power from net savers to net borrowers. First, the decreasing money market and longer rates encouraged banks to lower lending rates for new loans for consumption and house purchases after NIR were introduced (see FIG. No. 2). Although the downward trend could be seen even before

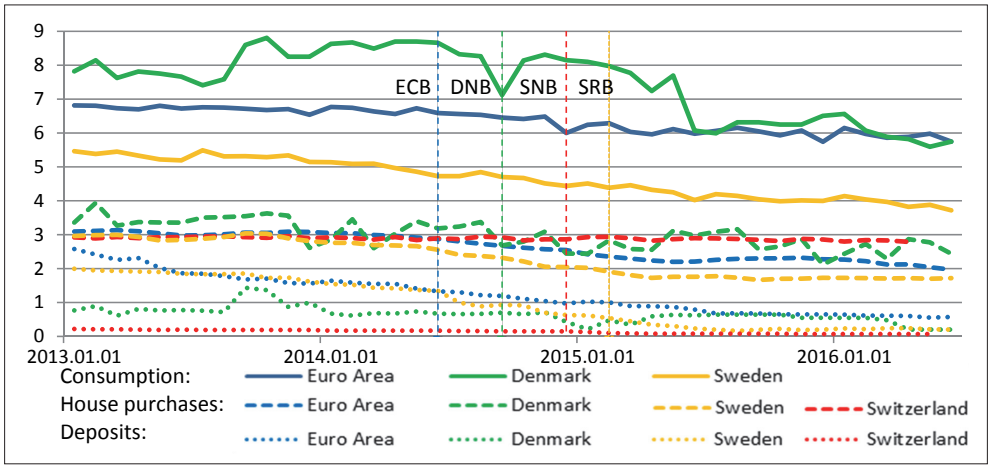

FIG. No. 2. **Rates of new loans to households for consumption, house purchases, and deposit rate, %**

Note: Vertical lines denote the date when central bank implemented negative policy rates. Japan is omitted from this and many other figures are too due to too short time series.

Source: author's calculations based on the data of the Statistical Data Warehouse and Thomson Reuters.

negative rates, the subsequent declines were mostly bigger than the reduction of policy rates, possibly due to other easing measures and an increasing competition among banks. The biggest decline can be observed in Denmark and especially in lending for consumption. However, mortgage rates declined marginally in Switzerland, while in Sweden it has declined not as much as the policy rate. Overall, ECB (2015) determined that households' interest payments have decreased substantially: from around 4 to 1.1% as a share of disposable income since 2008; this is especially evident in countries where fixed rate loans are less widespread, e.g., Finland, Portugal, Spain and the Baltic countries. Also, lower lending rates (even in the negative zone) led to an increase in demand to borrow and, as a result, supported consumption today through intertemporal substitution for future consumption (World Bank, 2015).

Deposit rates decreased, though less than with lending rates for mortgages or house purchases (see FIG. No. 2). However, there seems to be not much space for any further decrease of the deposit rate due to the zero lower-bound. Policy rates decreased much faster than deposit rates, e.g., in Switzerland, the deposit rate decreased by only a 0.08 percentage point. Overall, an average household's net interest income has been largely unaffected due to the higher absolute amount of savings. But as the resources moved from net savers to net borrowers, who have a higher marginal propensity to consume, the overall impact of NIR on aggregate consumption is more positive (Praet, 2016).

Currently, there are no signs of deposits' decrease or odd increase of cash holdings (see FIG. No. 3). Cash holdings have been increasing steadily and have not jumped after the introduction of NIR, while in Sweden it has been in a long-term downward trend. This is partly a result of the incomplete pass-through to deposit rates. As a result, the physical lower bound (cash storage costs) still remains uncrossed.

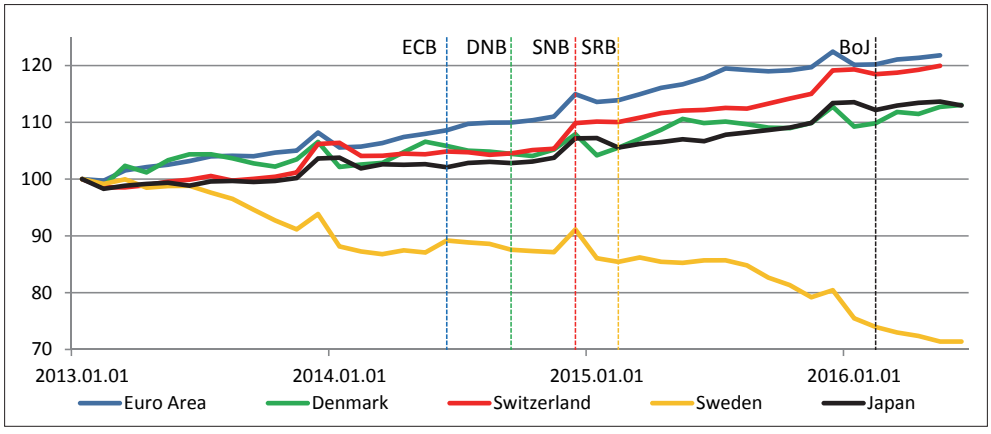

FIG. No. 3. **Banknotes and coins in circulation (normalised to 100 at 01/01/2013)**

Note: Vertical lines denote the date when a central bank had implemented negative policy rates.

Source: author's calculations based on the data of the Statistical Data Warehouse and Thomson Reuters.

- **Non-financial Corporations**

Reduced and even negative rates led to substantially lower non-financial corporations' (NFCs) funding costs (see FIG. No. 4). The biggest rate reduction can be observed in the euro area, where rates increased by almost 1 percentage point, i.e., 2.5 times more than the decrease of policy rates. In Sweden, lending to NFCs rates had been declining substantially both before and after SRB introduced negative rates and in line with policy rates both in positive and negative territory. As a result, these decreases led to lower the NFCs debt-to-equity ratios and higher profitability. Also, NIR helped to further compress not only the level, but also the dispersion of banks' lending rates, e.g., in the euro area countries, leading to the recovery of investment growth (Rostagno et al., 2016).

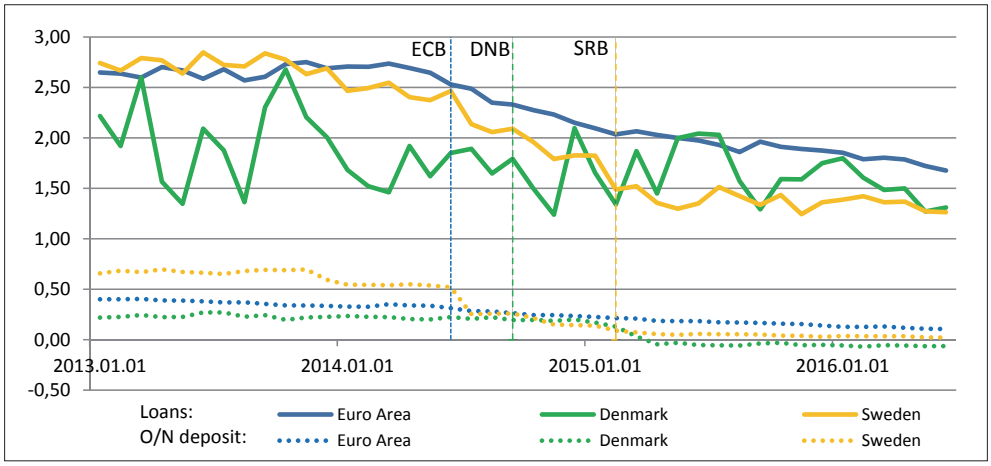

FIG. No. 4. **Rates of new loans to NFCs, %**

Note: Vertical lines denote the date when central bank implemented negative policy rates.

Source: author's calculations based on the data of the Statistical Data Warehouse and Thomson Reuters.

Similarly as in the case with households, banks also lowered their deposit rates to NFCs. Negative overnight deposit rates have been even applied to some institutional investors and some large firms – this is especially evident in Denmark's case. The possible reason might be the fact that interest rates on new loans to NFCs is lower than on households, so banks feel even more pressure to reduce deposits rates to NFCs. Interestingly, deposit growth rates for NFCs show that there is no sign of a disintermediation risk at the moment (Coeure, 2016). But a lower deposit earnings income puts pressure on the profitability of firms with high spare money. Overall, the NFCs that have higher willingness to invest win over those NFCs with higher deposits.

- **Banks and Non-bank Financial Institutions**

Banks in the countries where NIR are applied reduced their net interest margins (see FIG. No. 5). This decrease is mostly evident on loans for NFCs and in countries where

floating rate loans dominate. However, despite the downward stickiness of deposit rates, margins for house purchases remained remarkably steady and in some cases even increased, especially on loans for house purchases in the euro area. Also, NIR stimulated banks to increase lending volumes, so smaller interest margins did not materially affected the viability of banks (Praet, 2016).

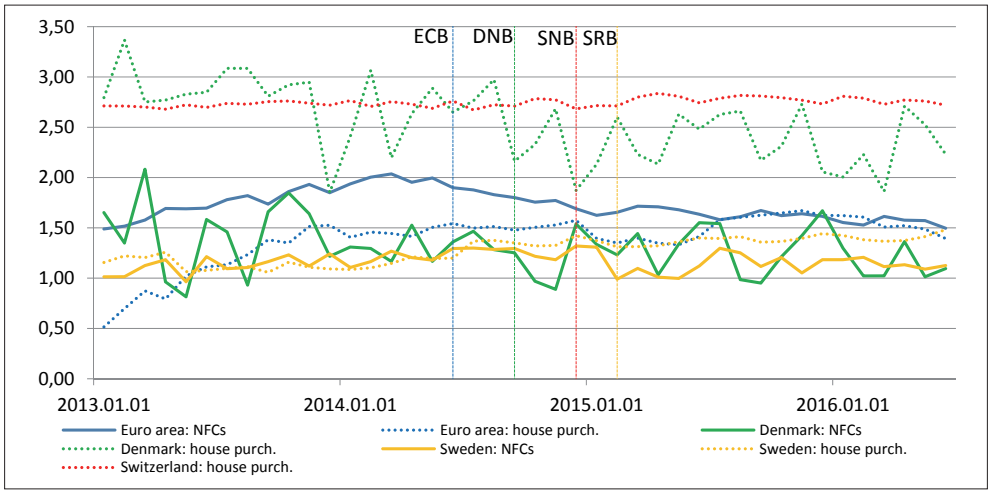

FIG. No. 5. **Net interest margins, %**

Note: Vertical lines denote the date when a central bank implemented negative policy rates.

Source: author's calculations based on the data of Thomson Reuters.

In the short term, the profitability of banks should increase as the positive effects outweigh negatives ones. Rising lending volumes and non-interest income, higher values of securities portfolios due to lower yields, smaller NPLs because of the decrease of clients' debt service burden and reduced funding costs partly offset the problem of deposit rate stickiness. All in all, banks' return of asset in countries with NIR has not changed materially (see FIG. No. 6). Highest returns are generated in Sweden and Switzerland, while the lowest – in Denmark and the euro area.

However, in the longer term, one-off gains will fade away and banks will feel a higher pressure on profitability and, as a result, the need to alter business models. The longer NIR are kept, the higher the possibility that banks will need to reduce margins due to deposit rate stickiness, while flatter yield curves imply lower profits from maturity transformation. Also, banks will need to replace matured higher-yielding bonds with negative-yielding assets – this implies lower profitability in the future. As investors reassess how low rates can go, focus on the downside risks to earnings and capital adequacy will increase. As a result, banks will need to change their business models: they will have to rebalance toward riskier assets and borrowers, increase the share of market financing and decrease the amounts of retail deposits, rely more on non-interest income and/or increase cost efficiency (Borio et al., 2015, The Bank of Lithuania, 2016).

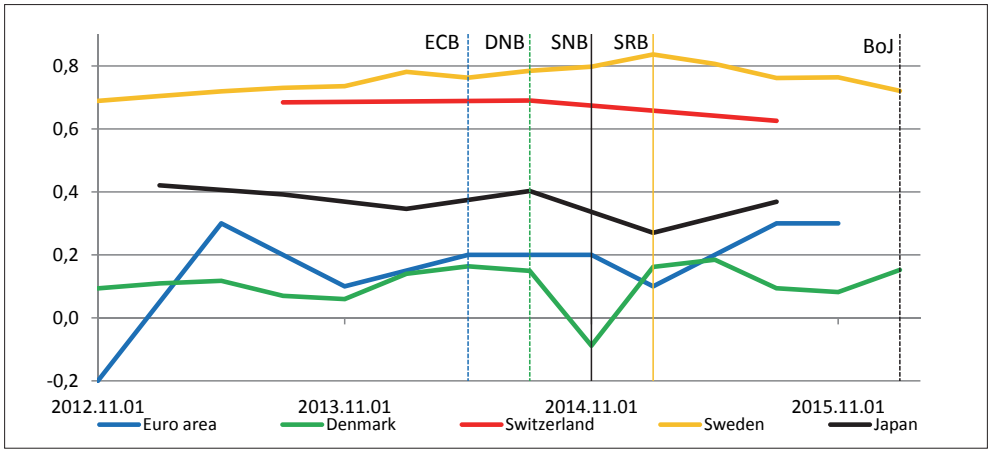

FIG. No. 6. **Return of asset of deposit taking institutions, %**

Note: Vertical lines denote the date when a central bank implemented negative policy rates.

Source: author's calculations based on the data of the IMF Financial Soundness Indicator and the Statistical Data Warehouse.

The effect of NIR on non-bank financial institutions is very similar to banks. These institutions (especially pension and life insurance companies) may be unable to meet their long-term liabilities due to fixed costs of their offered products, e.g., two-thirds of life insurance policies in force in the EU today offer some sort of guarantee that is not linked to market interest rates (The Economist, 2016). The biggest part of non-bank financial institutions' assets consists of investment grade fixed-income securities that have mostly risen in value after the central banks set negative policy rates, but in the longer term, the extremely low income of newly purchased securities could fall below the promised pay-outs to the policyholders (IMF, 2015). These challenges mean that non-bank financial institutions must change their business models, too: they ought to increase their search for higher yield, shift toward more market-based financing, merge with other institutions to reduce costs and/or begin developing new products whose pay-outs are more linked to market interest rates.

- **Governments**

Negative policy rates had reduced the borrowing costs of governments in all five countries as the bond yields have decreased substantially, particularly at the shorter end of the yield curve and, more recently, also at the longer term (see FIG. No. 1 in the Appendix). While policy rates have a more direct effect on the short-end of yield curve (the "signalling channel"), its impact on market participants' expectations about the path of future policy rate had an impact on longer-end yields too, mostly through the "balance sheet channel". The extra savings of refinancing led to lower deficits and, to some extent, higher spending. Moreover, NIR also has helped to reduce market fragmentation among

euro area countries as the difference spreads of Italian, Spanish and Portuguese bonds have decreased (Coeure, 2016).

The negative implications of NIR might become more evident in the long-term as many countries have already spent the extra savings for short-term political gains, but have not implemented necessary structural reforms or build reserves. Borio et al. (2016) emphasized that governments need to break their reliance on exceptionally low interest rates as it does not have long lasting effects on real economy. Many analysts (e.g., Slok, 2016) often highlight that the reform momentum has slowed and political uncertainty has increased after NIR were introduced and that they also have political implications in highly savings-dependent countries as Germany, Japan etc. When policy rates will finally be raised and become positive, many countries might find themselves financially unprepared for increased debt servicing costs and could even be unable to pay their debts on the agreed terms, meaning increased vulnerability in financial markets, reduced bond holders' willingness and ability to consume as well as invest and, ultimately, restrained economic development. These effects could become even more severe the longer NIR are kept and the faster policy rates are raised.

- **Asset markets**

NIR contributed to lower (or at least stable) value of domestic currency. Similarly as in the case with a cut of positive rate, NIR through the portfolio rebalancing channel led to higher capital outflows and, subsequently, depreciation of the domestic currency – in the short term, nominal effective exchange rates fell or at least stabilized in all five countries (see FIG. No. 7). However, the depreciation of domestic currency can lead to the so-called "currency wars" by causing a cycle of rate-cutting in different countries.

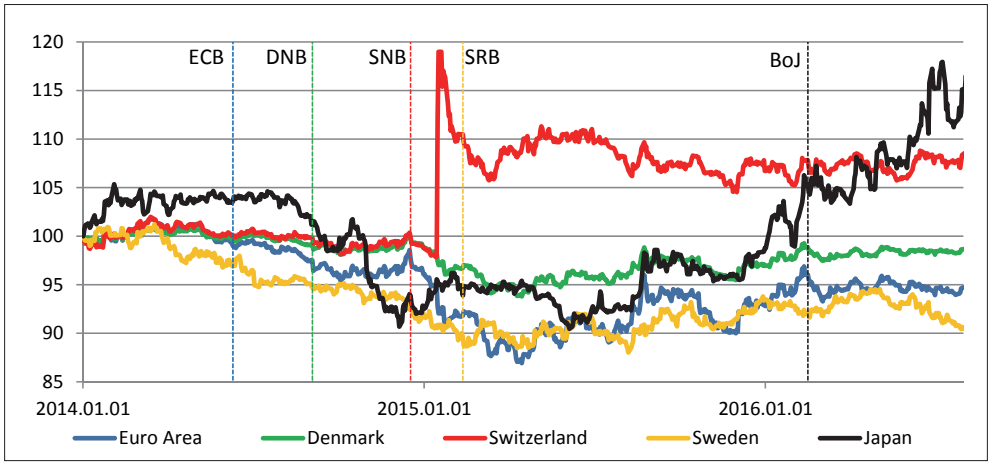

FIG. No. 7. **Nominal effective exchange rate, normalised to 100 at 01/01/2014**

Note: Vertical lines denote the date when central bank implemented negative policy rates.

Source: author's calculations based on the data of Thomson Reuters.

NIR positively affected prices of other asset markets to some extent. Increased risk taking, wealth effect and lower borrowing costs contributed to increasing house prices, though in a much slower manner than in previous cycles of house price increases (Rostagno et al., 2016). Also, NIR led to a similar effect on corporate bonds as in the case of government bonds – lower yields. Corporate bonds paying negative interest rates account for about $500 billion out of nearly $10 trillion in securities that yields below zero – the reason for this could be that negative policy rates are expected to stay for a long time (Cowen, 2016). However, values of stock indices in four countries (the only exception – Denmark) had not increased substantially after NIR were introduced (see FIG. No. 8). One of the possible reason could be the negative expectations on financial institutions' prospects in the long-term.

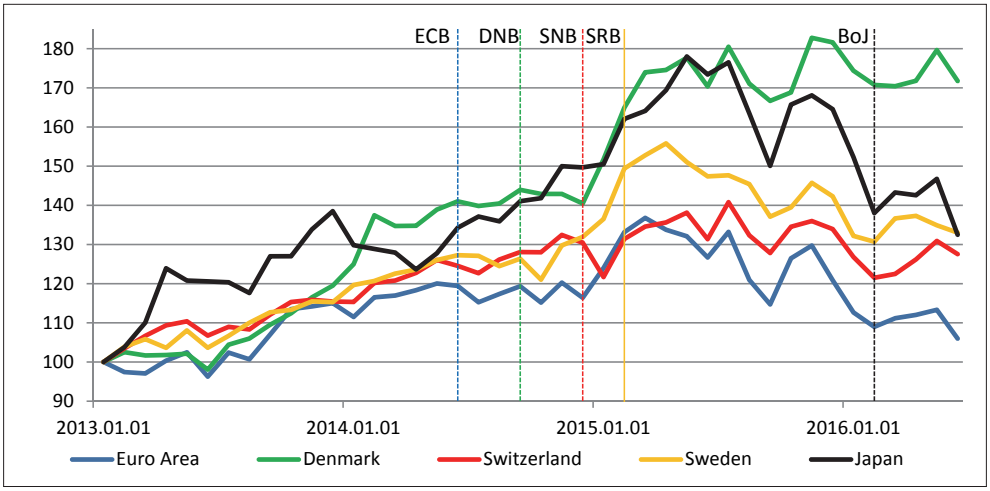

FIG. No. 8. **Stock market indices, normalised to 100 at 01/01/2013**

Note: Vertical lines denote the date when central bank implemented negative policy rates.

Source: author's calculations based on the data of Thomson Reuters.

The long-term implications of NIR on asset markets might outweigh the positive short-term effects. If NIR are kept for too long, portfolio rebalancing could lead to fundamentally overvalued asset prices. So, when chances of the reversal of monetary policy accommodation become more priced-in, investors might pull back their money – history tells that the slump of asset markets often leads to economic downturn. Also, market liquidity might become impaired as financial institutions alter their business models and their ability to provide liquidity diminishes. This could make the asset markets even more vulnerable to monetary policy shocks or expectations as witnessed by, for instance, the *Taper tantrum* in 2013 and *Bund tantrum* in 2015.

- **Macroeconomy**

All the above-mentioned effects (e.g., improved confidence, lower interest payments, higher exports, the profitability of firms and asset prices) have an impact on real econ-

omy of countries with NIR in the short run. However, the macroeconomic implications of negative policy rates are not straightforward as there are both "standard effects" of a monetary easing and "non-standard effects" related exclusively to NIR that become more evident in the long run.

Purchasing market indexes (PMI) have not yet responded in a common manner after NIR had been introduced (see FIG. No. 9). Nevertheless, it is important to note that not all central banks introduced NIR to stimulate growth. For instance, DNB, SNB and, to some extent, SRB wanted to lower the pressure on domestic exchange rate, while banks in Japan and Switzerland escaped a part of "tax" on excess reserves due to exemptions. As a result, the effects had been comparatively small.

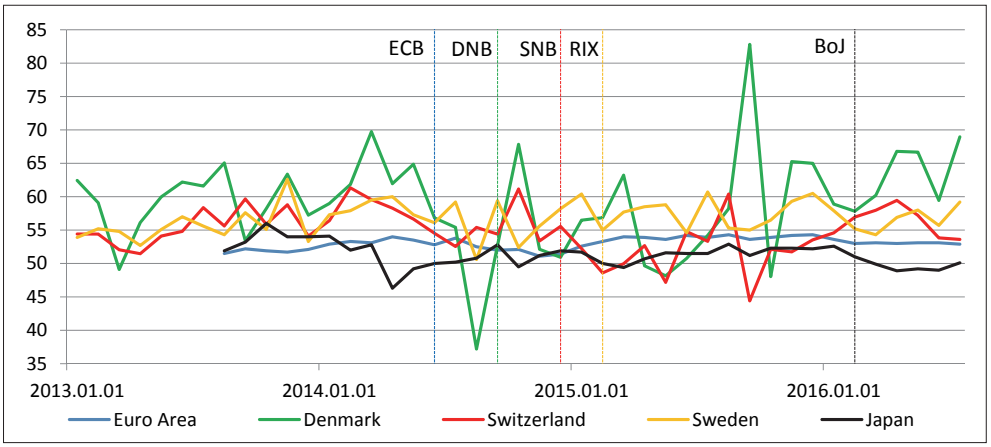

FIG. No. 9. **Purchasing market index (output)**

Note: Vertical line denote the date when central bank implemented negative policy rates.

Source: author's calculations based on the data of Thomson Reuters.

Medium-term inflation expectations had not recovered in the euro area (see FIG. No. 10). This contradicts the conventional thinking that lowering interest rates could heighten inflation expectations. However, the monetary policy package (including the negative deposit facility rate) helped to increase both inflation and GDP by 0.3-0.8 percentage points a year in 2015-2017 (Rostagno et al., 2016). The confidence effect, the fall of domestic currency value and higher wealth should provide an upward push to economic growth and inflation expectations in all the countries with NIR (The Economist, 2015). Still, the long-term effects are harder to predict due to the concerns of financial institutions' viability and excessive risk seeking in asset markets that lead to higher systemic vulnerability in the future – if these risks materialize, both inflation expectations and economic growth might be overwhelmed.

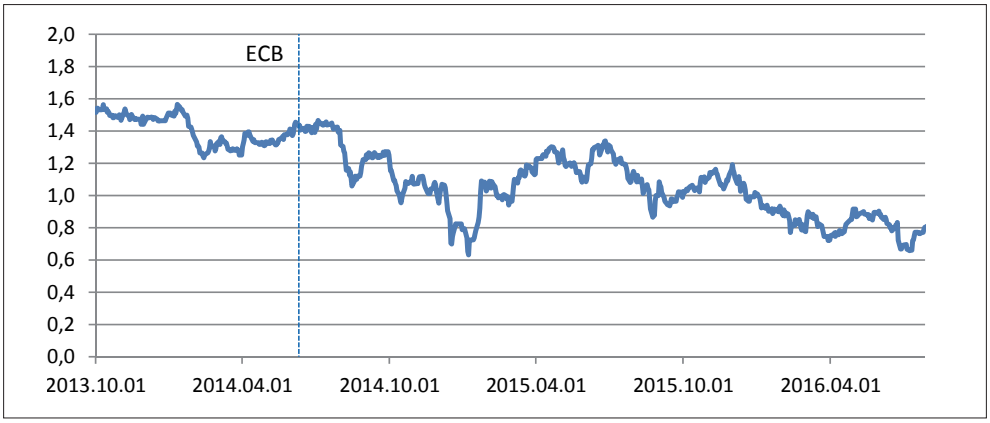

FIG. No. 10. **Inflation expectations (2y2y inflation swap forward) in the euro area, %**

Note: Vertical line denote the date when ECB implemented negative policy rates.

Source: author's calculations based on the data of the Statistical Data Warehouse.

5. Econometrical Analysis of the Impact of Interest Rate Reduction Shock in the Euro Area

As the regime of negative policy rates has been operational only for several years, it is still quite early to form an accurate and full-encompassing econometrical model for a quantitative evaluation of NIR effects. However, the analysis of interest rate reduction shock is a good starting proxy on what ultimate effects NIR might entail. The impulse-response function of the vector autoregression model is a suitable method for assessing the effects of interest rate reduction. This model helps to identify what the impact on variable is in t, t + 1, t + 2, etc., periods from a shock that happened in the t – 1 period of another variable; in this analysis – from a shock of interest rate reduction. The assumptions of impulse-response function are that this shock completely disappears in the next period and that the shocks of all other variables are equal to 0 (Jurkšas, Kropienė, 2014).

As the euro area is the largest region to introduce NIR and other central banks with NIR reacted to ECB actions, the analysis is performed on how the possible shock of a 3-month Euribor rate (which closely tracks the ECB policy rate) impacts various economic sectors. Several relevant variables for each economic sector were selected: deposit and lending rates of households and NFCs, as well as the indices of consumer and industrial confidence; the net interest margin of banks, capital position and stock prices; the broad stock market index; long-term government bond yields and the political uncertainty index; expectations of inflation and economic growth. The longest period of all data was obtainable from 2000 to March 2017. These daily or monthly variables were transformed to monthly time series, and, for a stationarity condition of the vector autoregression model, all variables were integrated by finding the first differences. Variables of stock market indices and the capital of banks were transformed into a linear form by using logs of such data.

The impulse-response functions of the constructed vector autoregression model revealed that a standard deviation unit shock of interest rate reduction significantly affects deposit and borrowing interest rates (see FIG. No. 11). Banks lower both deposit and lending rates soon after the ECB decreases policy rates. Interestingly, lending rates applied to NFCs decrease more rapidly, while the deposit rates are stickier than in the case with households, possibly due to the fact that NFCs receive much lower deposit rates than households. What is important, the net interest margins of banks decrease significantly and abruptly, too. This means that households and NFCs, on average, do "win" over the banks, at least shortly after the interest rates decrease.

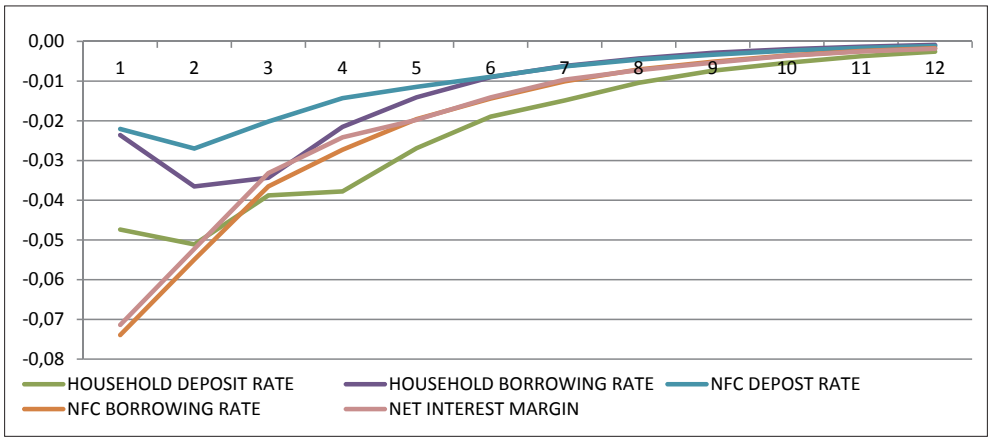

FIG. No. 11. **Response of interest rates to a standard deviation unit shock of interest rate reduction for 12 months**

Source: author's calculations based on the data of the Statistical Data Warehouse and Thomson Reuters.

However, market expectations of the banking sector prospects do not diminish so quickly. As higher equity prices and lower long-term yields positively affect the banks' securities portfolio and their capital position in the first periods after the shock, the stock prices of banks are somewhat positively affected by lower interest rates (see FIG. No. 12). Nevertheless, this effect swiftly disappears after several months, probably when one-off gains fade out and investors shift their focus to the net interest income of banks, their capital position and long-term viability. Although stock prices of the insurance sector fluctuate widely, they are on average not materially affected during the 12 month period after the shock.

Overall, the improvement of consumer and industrial confidence as well as increasing the bank and broad market indices lead to improving longer-term real economy prospects (see FIG. No. 13). The political uncertainty index decreased soon after the interest rate cut, possibly due to the reduced concerns of funding and debt-servicing costs, but this effect becomes overall muted in the longer term. Although consumer and industrial confidence might fall immediately after the reduction of interest rates, confidence gradually strength-

ens due to income (lower interest expense) and wealth (higher value of securities) effects of households and NFCs. More importantly, economic growth and, especially, inflation expectations pick up much slower and more gradually than other factors, confirming that the transmission from shock of interest rate reduction to real economy is long and indirect.

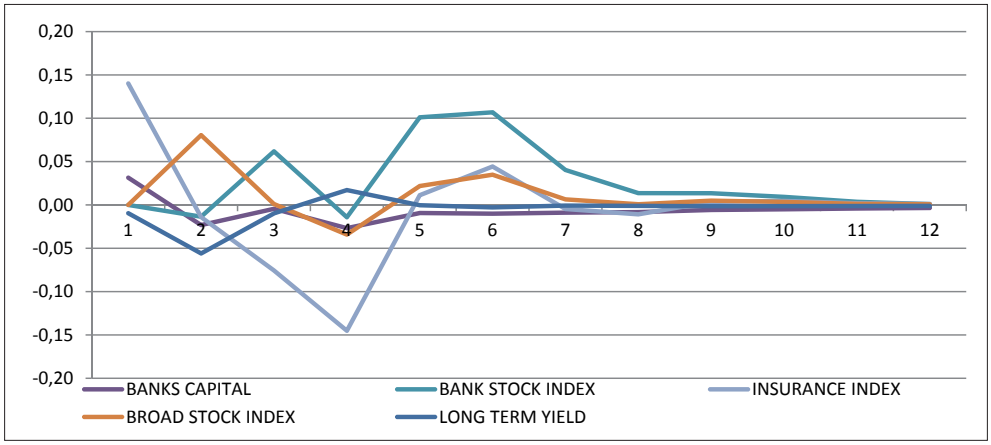

FIG. No. 12. **Response of banks' position and financial markets to a standard deviation unit shock of interest rate reduction for 12 months**

Source: author's calculations based on the data of Statistical Data Warehouse and Thomson Reuters.

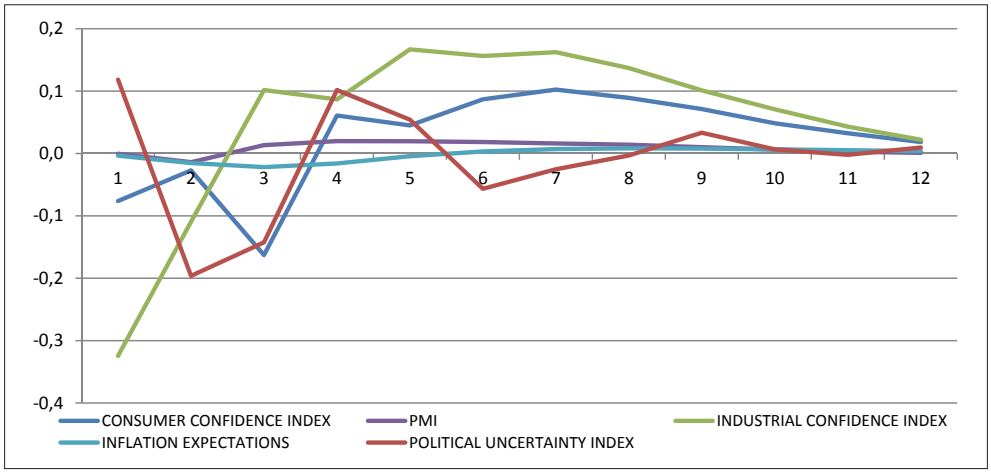

FIG. No. 13. **Response of expectations and confidence to a standard deviation unit shock of interest rate reduction for 12 months**

Source: author's calculations based on the data of Statistical Data Warehouse and Thomson Reuters.

It is important to note that while the low and negative rates have mainly positive impact for most of the economic sectors, negative effects might get exacerbated in the longer term. There are several negative externalities that negative policy rates might entail or that could materialize in the long run: an increased systematic risk due to higher

borrowing within the private sector and governments, the market concerns on the viability of banks to sustain lower net interest income and excess reserve charges and thus a need to alter business models, non-bank financial institution problems to meet long-term liabilities of fixed-rate products, cash hoarding, mispriced and more volatile asset markets etc. As a result, NIR might have more muted positive effects and entail more systematic vulnerabilities than in a case with a rate reduction in the positive territory, especially if negative policy rates are kept for a prolonged period of time.

6. Conclusions

The analysis of the central banks' stated goals to introduce negative rates revealed that the main reasons were persistently low inflation and upward pressures on domestic currency. Various exemptions effectively soften the burden of NIR and weaken the ultimate effect of negative policy rates. Still, many central banks that have a near zero interest rate resist introducing NIR due to the fear of lowering commercial banks' viability to lend and thus impairing the crucial element of effective monetary policy transmission.

The literature review carried out in this paper revealed that low and even negative rates are the results of real economy developments and global factors, some of which are of a secular nature, while others relate to the business cycle. Monetary policy should not be blamed for a long-lasting period of rate cuts and, ultimately, NIR, because policy makers respond to the dynamics of natural interest rates.

The statistical analysis showed that negative policy rates have significantly affected various economic sectors, but with different magnitude and efficacy. First of all, the pass-through from policy rates to the money market and the longer-term rates was full. Second, NIR led to an overall positive impact on aggregate consumption and redistribution of purchasing power from net savers to net borrowers. Third, NFCs that are more reliant on investments have benefited more than NFCs with higher share of deposits at banks. Fourth, the positive effect on banks' securities holdings, higher non-interest income, expanding lending volumes and lower loan losses offset the losses of reduced net interest margins and charges on excess reserves, but, in the longer term, one-off gains will fade away and banks may feel pressure to alter business models. Fifth, the mismatch between short-term assets and longer term liabilities may create increasing problems for non-bank financial institutions, though these risks will materialize not as fast as in the case with banks. Sixth, if the usage of extra savings from lower funding costs is spent duly by governments, the positive effects of economic growth might outweigh the negative implications of higher spending in the short-run, but a reliance on the reduced debt-servicing costs might diminish the necessity to implement reforms and decrease debts, implying certain increased vulnerabilities in the future. Seventh, NIR led to a somewhat downward pressure on value of domestic currency, but contributed to the increasing prices of majority of other asset markets. If prices and excessive borrowing keep increasing, asset markets might become fundamentally overvalued. Finally, the impact on economic

growth and inflation is highly uncertain in both short- and long-term due to the complex and indirect transmission mechanism of NIR.

Impulse-response functions of the vector autoregression model revealed what effects an interest rate reduction shock had for different economic sectors in the euro area. A decreasing short-term Euribor rate have reduced deposit and lending rates of households and NFCs, lowered the net interest margin, but, to some extent, positively affected bank equity prices in short-term due to a higher value of securities prices. Although these effects subsequently diminished, increased consumer and NFCs confidence as well as the muted effect on political uncertainty contributed to somewhat higher expectations of economic growth and inflation in the longer-term. With the current size of NIR, both physical and economical lower bounds seem to remain uncrossed.

However, in the long run, the positive effects should be more muted for a rate reduction in a negative rather than in a positive territory. There is increasing uncertainty about the behavior and risk seeking of individuals and institutions if rates were to decline further or remain negative for a prolonged period of time. This is especially true for the financial institutions' viability and asset market vulnerability. Also, if market expectations start looming over a turnaround of economic policy, or the sharp adjustment of securities' prices, positive effects could quickly evaporate and systemic risks might materialize in the longer run.

The results of this broad-based graphical, statistical and econometrical analysis provide the background for any further research of NIR effects as a longer history of time-series data becomes available and the impact on different economic sectors materializes in full and becomes more evident.

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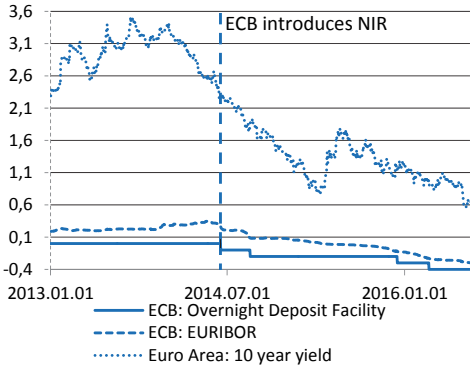

FIG. No. 1.1. **Rates in the euro area**

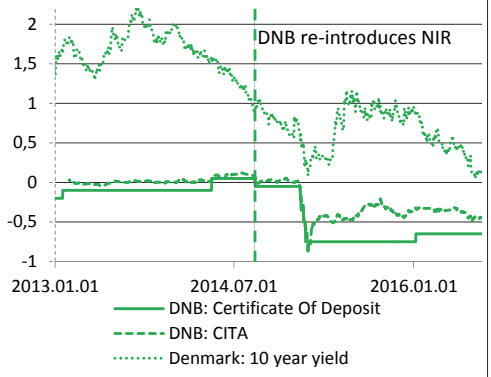

FIG. No. 1.2. **Rates in Denmark**

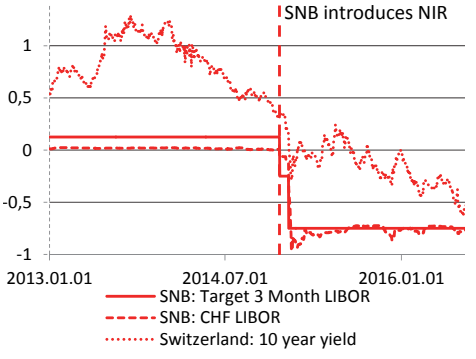

FIG. No. 1.3. **Rates in Switzerland**

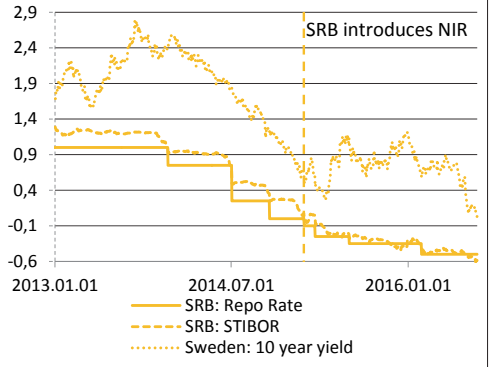

FIG. No. 1.4. **Rates in Sweden**

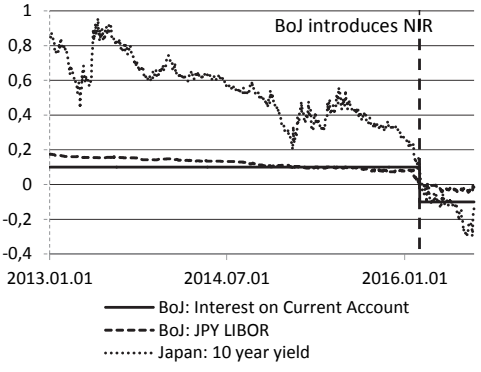

FIG. No. 1.5. **Rates in Japan**

FIG. No. 1. **Central banks' policy, money market and long-term rates**

Note: Vertical line denote the date when central bank implemented negative policy rates.

Source: author's calculations based on the data of Thomson Reuters.