DNB Research Program 2022

DeNederlandscheBank

EUROSYSTEEM

DNB Research Program

De Nederlandsche Bank NV
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Theme 1. Conventional and unconventional monetary policy

New projects

1. Learning and coherency of New Keynesian models with a zero lower bound constraint

Guido Ascari (DNB), Nigel McClung (Bank of Finland) and Sophocles Mavroeidis (University of Oxford)

In a previous paper Ascari and Mavroeidis (2021) show that New Keynesian models with a zero lower bound are generically incoherent under rational expectations, meaning they do not admit a rational expectation solution. In this paper, we investigate to which extent learning can provide a solution to this problem.

2. Efficient estimation of models with occasionally binding constraints

Paolo Bonomolo (DNB) and Sophocles Mavroeidis (University of Oxford)

We propose two methods to estimate models with occasionally binding constraints: a maximum likelihood strategy and a Bayesian approach. With respect to existing methods, we improve the efficiency of the estimators through the analytical derivations of the likelihood and of the posterior distributions of the parameters and latent processes. Our methods are simpler to implement and faster. We apply our estimation strategy to the CKSVAR model of Mavroeidis (2021) and use it to measure the contribution of conventional and unconventional monetary policies in the Euro Area and US.

3. Yield curve control

Sami Alpanda (University of Central Florida), Serdar Kabaca (Bank of Canada) and Kostas Mavromatis (DNB)

We consider a dynamic stochastic general equilibrium model with three types of agents (savers, borrowers and renters) and housing to analyze the efficacy of targeting the long-term interest rate along with the short-term interest rate (i.e., yield curve control) for implementing monetary policy in normal times. The long rate differs from the short rate due to portfolio costs, and affects aggregate demand directly through its partial pass-through to mortgage rates on borrowers. We first characterize optimal monetary policy in a simple version of the model, and show that the presence of heterogeneity (and exuberance shocks on house prices) generate a crucial role for targeting the long rate along with the short rate even in the absence of markup shocks or wage rigidities. We then estimate a full-blown version of the model to consider the quantitative importance of yield curve control for welfare and macroeconomic stabilization.

4. Monetary-fiscal interactions

Guido Asscari (DNB), Anna Florio (Politecnico di Milano) and Alessandro Gobbi (University of Milan)

This is an ongoing research agenda consisting of two projects. The first project relates to the adoption of a "makeup" strategy has been one of the proposals in the review of the Fed's monetary policy framework. Another suggestion, to avoid the zero lower bound, has been a more active role for fiscal policy. We put together these ideas to study price level targeting under a fiscally-led regime. We find that following a deflationary demand shock: (i) the central bank increases (rather than decreases) the policy rate; (ii) the central bank, thus, avoids the zero lower bound; (iii) price level targeting is generally welfare improving if compared to inflation targeting. In the second project we analyze the effects of anticipated government spending shocks in a monetary-led and fiscally-led regime. We show that the different effects in these two regimes could explain the impulse responses

of anticipated government spending shocks in the Great Inflation and Great Moderation period in the US data exhibited by standard VAR analysis.

Continued projects

1. The macroeconomic effects of the ECB's balance sheet policies
Gavin Goy (DNB) and Gregor Boehl (University Bonn)

We estimate a large-scale DSGE model based on our previous work (DNB WP 691) to estimate the effects of the ECB's liquidity measures and asset purchases since the global financial crisis on euro area GDP and inflation. To this extent, we extend our previous model by central bank reserves in order to allow for negative interest rates and the accompanied negative effects on bank's profitability.

2. A tolerance band around the inflation target: (when) does it work?
Dennis Bonam (DNB) and Gavin Goy (DNB)

We study the effectiveness of adopting a tolerance band around the central bank's inflation target using an estimated DSGE model that accounts for the effective lower bound. The tolerance band is modelled as an endogenous regime switching process in which the central bank responds more aggressively to inflation once deviations from target exceed some predetermined margin. We find that the relative performance of the tolerance band in stabilizing inflation, compared to a baseline in which the central bank follows a point inflation target, depends on the type of shock hitting the economy. Moreover, the gains from adopting a tolerance band are particularly large when inflation is more persistent or when expectations are more backward looking. Finally, the tolerance band does not necessarily imply more frequent ELB spells, despite interest rate cuts being fiercer when inflation falls below the band.

3. Unintended effects of quantitative easing: An assessment of the safety premium channel
Gavin Goy (DNB), Dennis Bonam (DNB) and Ansgar Rannenberg (NBB)

The objective of this project is to show that quantitative easing, when aimed at purchasing long-term government bonds, can have contractionary effects insofar as long-term government bonds are considered as exceptionally safe and liquid, and thereby hold a safety premium over other assets. As QE reduces the supply of such safe assets, the safety premium rises which implies an increase in the spread on other assets, through which potential contractionary effects of QE may ensue. Of course, these effects may be offset through other positive effects of QE, such as lowering the term premium. However, in times of excessive stress, when demand for safe assets is particularly high, and during a liquidity trap, when long-run yields are already low, the contractionary effects may dominate. We aim to illustrate the safety premium channel of QE in a sticky price general equilibrium model with financial frictions. We also show that, if the safety premium channel is very strong, it may be better to gear QE towards the purchase of assets that do not hold a safety premium, such as private bonds.

4. Detecting liquidity traps
Paolo Bonomolo (DNB), Yildiz Akkaya (Konjunkturinstitutet) and Ingvar Strid (Sveriges Riksbank)

Major economies experienced a period of low interest rates and low inflation. A possible explanation is that they fell in a liquidity trap. This is an equilibrium situation in which the policy rate is at the effective lower bound and inflation fluctuates around a negative or very low value. Ending in a liquidity trap is a big risk for the policy maker and we develop an econometric strategy to quantify this risk. We show that the methodology is able to

recognize when the probability of converging to a liquidity trap is high before the interest rate approaches the lower bound.

5. Estimating DSGE models with finite horizons

Kostas Mavromatis (DNB), Joep Lustenhouwer (University of Heidelberg), Mike Tsionas (Lancaster University) and Giorgio Motta (Lancaster University)

We augment the Smets-Wouters (2007) model to account for households' and firms' bounded rationality. In particular, we assume that both form decisions up to a finite number of periods to the future. We estimate the model using a novel estimator. Our estimates show that the planning horizon of agents varies from 20 to 25 quarters ahead. Moreover, given the finite horizon in agents' decisions, we show that the responses of output, inflation and investment in the U.S. are more pronounced following fundamental shocks.

6. Assessing the impact of conventional monetary policy on the capital-labor ratio in Brazil

Guilherme Moura (Federal University of Santa Catarina) and Aishameriane Schmidt (DNB, Erasmus University Rotterdam)

To empirically investigate redistributive effects of conventional monetary policy shocks in Brazil, we use the series of the capital-labor ratio, as well as GDP, inflation rate, and interest rates in our proposed extension of Uhlig's (1997) Wishart BVAR to a time-varying parameter framework. The data used for posterior computations comprises the monthly observations between March 2000 to October 2018, which corresponds to the inflation targeting regime in the Brazilian economy. The results show a positive and significant response of the capital-labor ratio to contractionary monetary shocks, which lasts at least a semester, suggesting the existence of a non-negligible redistributive effect of monetary policy. Moreover, this response is not constant across periods, and changes in the impulse response functions across the sample were observed due to a time-varying behavior of some of the model parameters. In particular, the strength of the impact of monetary shocks on the capital-labor ratio has diminished in the last sample periods analyzed.

Theme 2. Inflation

New projects

1. The relation between idiosyncratic volatility and price setting
Emmanuel De Veirman (DNB) and Raphael Schoenle (Brandeis University)

Idiosyncratic shocks play a crucial role in state-of-the-art price setting models. For instance, they are in line with the fact that one observes a substantial share of price declines even with positive inflation. In this paper, we test the implication from price-setting models that idiosyncratic volatility relates positively to the frequency of price adjustment. This relation is important for monetary policy given that theoretically, more frequent price adjustment implies a steeper Phillips curve.

2. Consumers' inflation expectations: insights from a monthly survey
Richhild Moessner (BIS), Gabriele Galati (DNB) and Maarten van Rooij (DNB)

There is an increasing interest among policy makers and academics in the formation of inflation expectations of consumers. This projects aims to better understand inflation expectations using results from an ongoing consumer survey. Topics include the level and probability of inflation expectations, anchoring of long-term inflation expectations, developments during a period of regime changes and increasing inflation realizations, and the role of information provision.

3. Inflation dynamics and imported intermediate goods in the eurozone
Guido Ascari (DNB), Luca Fosso (University of Pavia) and Wisse Rutgers (DNB)

This projects aim at applying the methodology in Ascari and Fosso (2021) to eurozone data. The aim is to study how much the dynamics of eurozone inflation is affected by cost-push factors due to the international fragmentation of production, i.e. global value chains. We will investigate whether the dynamics of intermediate imported goods affect both the trend and the business cycle behavior of eurozone inflation, that is, to what extent it might explain both the fact that eurozone trend inflation has been below target for the last two decades and the apparent disconnection with the domestic business cycle.

4. Macro footprints of perceived inflation in private consumption: The case of the US, Canada, Europe and Japan
Ad Stokman (DNB)

From the second half of 2021 on, consumers all over the world experience rising inflation, both in terms of perceived inflation as well in terms of inflation expectations. Households' reported inflation expectations particularly strongly correlate with price rises for food and energy. What are the consequences for spending of this focus on a subset of the consumption basket? At the micro level, the findings are mixed and depend on the savings motive and whether or not nominal interest rates hit the lower bound. At the macro level Stokman (2022) provides evidence for the euro area that rising inflation perceptions have a strong downward effect on consumer confidence and real private consumption growth. Does this finding also hold for the US, Canada, the UK and Japan?

Continued projects

1. Forecasting Dutch inflation using machine-learning methods
Robert-Paul Berben (DNB) and Jasper de Winter (DNB)

Despite the benefits of forecasting inflation accurately, improving simple models has proved challenging. This research explores advances in machine learning (ML) methods to forecast Dutch inflation. We investigate whether ML models with a large number of

covariates are systematically more accurate than simple benchmark models, such as AR and RW. Amongst other we will investigate (polynomial) shrinkage methods, (targeted/boosted) factor models, ensemble methods, random forests and neural networks.

2. Bounded rationality, noisy signals and monetary policy assessment

Kostas Mavromatis (DNB), Tolga Ozden (Bank of Canada) and Joep Lustenhower (University of Heidelberg)

We introduce household bounded rationality in a closed economy where firms have noise signals as regards the demand for their products. We follow Hommes et al. (2019) and Slobodyan and Wouters (2012) and assume that households use simple heuristics to forecast inflation, output, consumption and the future monetary policy stance. Firms operate in a monopolistically competitive environment and set the price of their goods infrequently. Firms are uncertain about the demand conditions in their sector. In particular, we assume that when setting the price, firms observe the demand for their product with some noise. This channel introduces an additional layer of uncertainty in our model. We assess the performance of simple monetary policy rules, namely inflation targeting, average inflation targeting and price level targeting. Subsequently, we compare our results to those from the rational expectations benchmark where households and firms share the same information set.

3. Inflation fluctuations and liquidity constraints

Jakob de Haan (University of Groningen) and Irina Stanga (DNB)

This project is motivated by two factors. First, in the eurozone as well as in the Netherlands, core inflation has declined relatively little during the Great Financial Crisis and its aftermath and it has increased relatively little during the current recovery. Second, it is likely that liquidity constraints were more pronounced during the Great Financial Crisis and its aftermath than at other times. We link these two factors by investigating how liquidity constraints affected firms' pricing actions in the Netherlands, as what Gilchrist et al. (2017) do for the United States. We use a micro dataset on prices and liquidity of Dutch firms.

4. Climate change and inflation forecasts

Adriana Cornea-Madeira (University of York), Domenico Massaro (University of Milan) and Kostas Mavromatis (DNB)

We analyze the impact of climate change and climate related government and central bank interventions on inflation expectations. We use an index that measures how market participants' sentiment changes following announcements related to climate change or to climate related policy measures. We proxy inflation expectations by using disaggregated data on forecasts from Consensus Economics.

5. Does it matter how you target? Performance of point, band, and range targets for inflation

Anna Samarina (DNB, European Central Bank)

We construct a new database of inflation targets for 55 countries over the period 1990-2018. We distinguish three types of inflation targets used by central banks: point target, point target with a tolerance band, and range target. Using this database, we examine how effective are different types of targets in achieving price stability. That is, whether the distinction between inflation target types matters for inflation performance, its volatility, and expectations.

6. Drivers of the Euro area economy: A nonlinear semi-structural approach
Gavin Goy (DNB), Claus Brand (European Central Bank), Carlos Montes-Galdon (European Central Bank), Mario Porqueddu (European Central Bank) and Mate Toth (European Central Bank)

What are the long-term drivers of the euro area economy? To answer this question, we estimate a non- linear semi-structural model with stochastic volatility for the euro area. We show how lower productivity growth, rising risk aversion as exemplified by a rise in the convenience yield and demographics have contributed to a fall in the natural rate of interest. Together with a decline in neutral inflation this explains the observed fall in nominal rates to historical lows. Using the model, we also document a declining elasticity of inflation to demand shocks.

7. The long-run Phillips Curve is….a curve
Guido Ascari (DNB), Paolo Bonomolo (DNB) and Qazi Haque (University of Adelaide)

In US data, inflation and output are negatively related in the long run. A Bayesian VAR with stochastic trends generalized to be piecewise linear provides robust reduced form evidence in favor of a threshold level of trend inflation (around 4%). Below this threshold potential output is independent of trend inflation, while above it potential output is negatively affected by trend inflation. A New Keynesian model generalized to admit time-varying trend inflation provides theoretical foundations to this reduce form evidence, by reproducing it once the model is estimated via particle filtering. The structural Long-run Phillips Curve implied by the estimated New Keynesian model is not statistically different from the one implied by the reduced form piecewise linear BVAR model.

Theme 3. Monetary policy, financial markets and credit

New projects

1. **Who participates in the credit market during the covid-19 pandemic? Evidence from the Consumer Expectations Survey**
Evangelos Charalambakis (Bank of Greece), Federica Teppa (DNB, Netspar) and Athanasios Tsiortas (European Central Bank)

This paper provides new evidence on what determines the probability of the consumer's decision to apply for credit as well as the probability of the consumer credit being accepted by financial institutions. It also analyses whether and to what extent the covid-19 pandemic impacts on consumers' borrowing behaviour. We use novel microdata between April 2020 and April 2021 obtained from the new ECB's Consumer Expectations Survey, a fully harmonized online survey measuring consumer expectations and behaviour. We find that age, education, household size, income, financial literacy, liquidity constraints and degree of urbanization significantly impact on both the application and the acceptance of credit. We also document that the probability for credit application and for the credit being accepted vary across countries. Finally, we find that there is heterogeneity in the type of credit and in particular for secured versus unsecured loans.

2. Credit ratings and investment
Anna Bayona (ESADE), Oana Peia (University College Dublin) and Razvan Vlahu (DNB)

With their role as information intermediaries, credit rating agencies (CRAs) may impact firms' capital structure, capital investments, and growth. One of the key aspects on which the existing literature is far from conclusive is the informational value of ratings. On the one hand, there are concerns that the CRAs played a central role in financial failures by misleading creditors through inflated ratings. On the other hand, arguments support the importance of ratings in mitigating the problem of asymmetric information. This research project's primary goal is twofold. First, we provide a theoretical framework to analyze how an informative (though potentially inflated) credit rating affects creditors' investment decisions. Second, we conduct laboratory experiments to uncover empirical evidence on the potential real effects of credit ratings.

3. Banking sector composition and monetary transmission: evidence from the euro area
Stephen Kho (DNB)

I consider whether the transmission of monetary policy to corporate borrowers and lenders is affected by the concentration of the local banking sector, and by the sector's composition of small and large banks. Using high-frequency monetary policy shocks and both sector-level and individual bank-level data, I establish that the euro area banking sector could be characterised as consisting of two different environments. On the one hand, there are four large economies that have fragmented (i.e. not concentrated) banking sectors, including, however, also a few large banks that are able to exercise market power by temporarily raising spreads more than their smaller competitors after a monetary policy shock. On the other hand, we have smaller economies where the response of lending and deposit rates to monetary policy shocks are affected by the degree of sector concentration, but these effects do not appear to be driven by banks' market share.

4. Heterogeneous access to loans across sectors: evidence from AnaCredit and the Bank Lending Survey
Stephen Kho (DNB)

One explanation for the low post-GFC credit growth in the Netherlands is that Dutch firms are more service-based, have little collateral to offer and thus may not as easily obtain

loans from banks. The lack-of-collateral argument would imply that service firms suffer more from shocks to credit supply, as they are all else equal riskier. Using the Dutch edition of the quarterly Bank Lending Survey, in which banks report their expectations and observations with regards to credit supply, and AnaCredit, a credit registry for non-financial corporate bank loans, we assess whether a shock to credit supply indeed disproportionally reduces access to bank loans for service firms. In an extension, we could assess whether this effect is mitigated by banks that take part in TLTRO.

5. Excess liquidity and the usefulness of the money multiplier
Jan Marc Berk (DNB) and Jan Willem van den End (DNB)

Despite being an identity, the money multiplier (MM) also is a useful summary of the financial intermediation process. By modelling the supply and demand for inside and outside money, we provide the MM with behavioural underpinnings. Our model illustrates how the creation of large outside money balances by central banks induces behavioural changes, creating an environment characterised by a low MM and low market interest rates. The outcomes of switching regressions for the US and the euro area confirm that such a low regime can be distinguished from a conventional MM regime. The low regime reflects a state in which the functioning of the financial system changed fundamentally due to excess supply of reserves. This so-called excess liquidity trap has adverse economic consequences, is persistent, and cannot be solved by monetary policy alone. We argue that government and supervisory measures taken during the pandemic provide an example of supporting policies that were effective in escaping the excess liquidity trap.

6. Banks' usage of TLTRO funds
Tomas Carrera de Souza (DNB)

The recalibration of the parameters of TLTRO as a response to the pandemic led to a large participation by banks, who had an incentive to frontload their take-up regardless of their liquidity needs. In this paper I analyse to what extent TLTRO funds were used for the purchase of government bonds with "carry-suitable" characteristics. Two characteristics of TLTRO.III make it unique as compared to earlier refinancing operations. First, banks' take-up was mostly driven by their borrowing allowances, which allows to treat TLTRO.III as an exogenous shock. Second, many banks had already beat their lending benchmarks by the time of their participation, which ensured access to the special interest rate without the need to further increase credit supply.

7. The transmission of unconventional monetary instruments: The impact of negative rates on insurance companies
Joost Bats (ECB), Aerdt Houben (DNB, University of Amsterdam) and Massimo Giuliodori (University of Amsterdam)

This paper investigates insurance companies' stock performance following different monetary policy actions in times of positive and negative interest rates. Given the introduction of unconventional monetary policy instruments, it is important to make a distinction between the different instruments central banks use to intervene on different segments of the yield curve. Unanticipated changes to different segments of the yield curve are identified with high-frequency data around all ECB monetary policy announcements from 1999 to 2022.

8. Macroeconomic implications of price and liability dollarization
Daniela Hauser (Bank of Canada) and Kostas Mavromatis (DNB)

Latin American emerging market economies have traditionally been subject to dollarization. The latter may refer to either goods being priced in dollars, or to local governments issuing dollarized bonds. Importantly, the share of dollarized sovereign debt has been increasing over the past years. We build a small open economy (SOE) DSGE model accounting for those facts in order to explore the effects of US monetary policy on

dollarized economies. We show that the exchange rate effects of changes in US monetary policy have non-negligible effects on those economies. The local currency depreciation due to the imminent increases in the Federal Funds Rate not only raises the domestic currency value of dollar denominated debt but also leads to an increase in the risk premia attached to it. Hence, local governments can be subject to pressures to consolidate, deepening thus the induced recession. We derive the endogenous degrees of price and liability dollarization and argue that local governments can appropriately target them in order to minimize the risks of exchange rate fluctuations.

9. Asset purchases and the scarcity premium in repo rates
Tomás Carrera de Souza (DNB) and Tom Hudepohl (DNB)

As the Eurosystem's footprint increases, the impact of asset purchases on market functioning intensifies. By swelling asset scarcity, our purchases push repo rates lower, and investors need to pay more to borrow scarcer bonds. This scarcity premium drives money market rates away from policy rates and may lead to frictions in repo and (cash) bond markets, hampering the price discovery process. Lower repo rates also increase the attractiveness of the Eurosystem's Securities Lending Facility (SLF) vis-à-vis the private market. This paper quantifies the flow- and the stock-effect of QE-driven scarcity on repo rates. Moreover, we investigate whether the SLF effectively alleviates the downward pressure on repo rates.

Continued projects

1. Integration of funding and market liquidity in real estate
Dorinth van Dijk (DNB), Yumei Wang (University of Amsterdam) and Marc Francke (University of Amsterdam)

In commercial real estate markets, market liquidity tends to commove stronger than returns. As trading requires capital, we hypothesize that part of the strong co-movements in market liquidity are determined by changes in capital markets, i.e. funding liquidity. Because capital markets, as opposed to space markets, are mostly nationally or even internationally integrated, this provides a reasonable explanation why commercial real estate market liquidity is so strongly integrated across markets. By using and constructing several measures for funding liquidity, we provide robust evidence that changes in funding liquidity drive common changes in market liquidity.

2. Quantitative easing and (international) portfolio rebalancing
Tom Hudepohl (DNB)

The portfolio rebalancing channel is often cited in literature as one of the most important, and perhaps one of the most effective channels through which Quantitative Easing (QE) can affect the economy. Most studies that look at portfolio rebalancing consider the euro area as a closed economy. However, QE also comes with important open-economy aspects. In order to address the open character of the euro area, we will look at international portfolio rebalancing. Addressing the question of international portfolio rebalancing will be done in two ways. One particular way investors can resort to portfolio rebalancing is by means of carry trades. By taking a look at the positions of euro area investors, we will investigate the impact of QE on carry trades. This will first be done by looking at whether euro area investors increased their risk-taking via an increase in exposure on liquid instruments in other currencies. Second, we will look at whether euro area investors resorted to international portfolio rebalancing by increasing instrument risk on their balance sheets.

Theme 4. Financial stability and financial regulation

New projects

1. Excessive savings and saving incentives in the Netherlands: The effect of housing market policy on adequacy of pension wealth
Mauro Mastrogiacomo (DNB, VU Amsterdam, Netspar)

We investigate the effect that currently discussed policies on the housing/mortgage market could have on desirable pension savings in relation to housing wealth. Currently booming house prices might induce policies geared at cooling the housing market, and at the same time alter the perception of desirable pre-pension savings of the general public. We survey the opinions on a desirable relationship between housing wealth and pension wealth in the DNB Household Survey (DHS). In the survey, we pay specific attention to self-employed, a group increasing in number and not subject to compulsory pension savings. We focus on the notion of excessive savings and excessive fiscal stimulus to saving, both in housing and in the second pillar. We concentrate on policies related to restricting credit to new buyers and their potential effect on house prices and thus on housing wealth. This means that our research will be based on 3 specific steps. First we deliver new descriptive survey evidence on the concept of desirable pension, including a measure of excessive savings. Also, this measure relates excessive (pre-pension) savings to housing wealth. Second, we set up a quasi-natural experiment investigating the causal effect of housing market policy on house prices. Once we have computed the needed elasticities, the third part of the study links the first two steps by simulating a credit restriction and by computing the effect on housing wealth and on the relative measure of excessive pension savings.

2. No house and no pension? The effect of LTV limits on the housing wealth accumulation of self-employed
Mauro Mastrogiacomo (DNB, VU Amsterdam, Netspar) and Cindy Biesenbeek(DNB)

Investing in housing could be an attractive alternative to privately saving for a pension, definitely so for those who are not obliged to save for an occupational pension, the self-employed for instance. But access to the housing market requires a down payment. Macroprudential measures, such as loan to value (LTV) norms could hamper access to the housing market for young buyers and require additional saving for this purpose. We study the effect of the introduction and sharpening of the LTV limit in The Netherlands on the probability of self-employed and wage employed to become homeowners. We construct a treatment and control group using parental wealth as a proxy for being liquidity constrained. We show that during the period in which the LTV limit was introduced, self-employed were about 40% less likely to purchase their first home, relative to wage employed and relative to periods without LTV being limited. However we show that this was not caused by lowering the LTV limit, but by contemporaneous cofounding factors. Sharpening the LTV limit has not reduced the probability to become home owners for self-employed. We also show some evidence suggesting that their status put self-employed workers at a disadvantage when the policy was enacted, possibly inducing dynamic selection out of self-employment.

3. Till debt do us part: Strategic divorces and a test of moral hazard
Mauro Mastrogiacomo (DNB, VU Amsterdam, Netspar), Yeorim Kim (VU Amsterdam), Stefan Hochguertel (VU Amsterdam) and Hans Bloemen (VU Amsterdam)

We test whether prospective losses on the housing market induced moral hazard in the form of divorce. Qualifying homeowners can buy into a guarantee scheme; a lender's insurance against borrower default that transfers the risk to the public. Divorce is one of the major events following which the guarantor repays outstanding residual debt after (foreclosure) sale. We argue in this paper that divorce is endogenous to holding

underwater mortgages, and hence constitutes a strategic choice. Using administrative data, we find a 11% increase in the chance to divorce, causal to being insured. The identification relies on a regression discontinuity design, exploiting the fact that the insurance is only available for properties with values below a legislated threshold. The house price crisis (2008-2013) provides an unexpected shock in house values, leaving about 40% of owners with an underwater mortgage, and with negative home equity of about €50.000 on average. Observationally similar couples above the threshold experienced significantly less often a divorce, relative to couples below the threshold.

4. Bank capital and risk shifting
Maurice Bun (DNB, University of Amsterdam) and Eric Cuijpers (DNB)
We study the impact of bank capital requirements on portfolio size using data on portfolio characteristics and capital requirements for a sample of large EU banks in the years 2014-2020. Exploiting a dynamic panel data model we relate capital requirements and capital headroom at the bank and portfolio level to exposure. We find that higher requirements reduce portfolio size, but this reduction is substantially larger for low risk portfolios than for high risk portfolios. These effects are not evidence of risk shifting behavior by bank managers, but can be explained by demand and supply credit markets. The policy implication is that time varying capital requirements, like the countercyclical capital buffer, can be used to influence bank exposure. However, regulators should be careful to interpret the risk reduction as linear function of reduction of exposure: banks shed their safer assets, leaving their volume of higher risk assets unchanged.

5. The preferential treatment of sovereign debt
Eric Cuijpers (DNB), Maurice Bun (DNB, University of Amsterdam) and Massimo Giuliodori (University of Amsterdam)
Large holdings of (home) sovereign debt by banks have negative effects on real output and financial stability. The literature has found risk shifting, carry trade behavior and moral suasion as causes of these large (home) holdings. This paper contributes by investigating to what extent the preferential regulatory treatment, i.e. zero risk weight, is a contributing factor in the emergence of large (home) sovereign portfolios. Using a novel dataset of EU bank's sovereign portfolios broken down by member state and regulatory approach (SA vs. IRB), we identify to what extent the zero risk weight facilitates the mechanisms identified by the literature. If zero risk weights facilitate banks' large holdings of (home) sovereign debt, the policy implication is that risk shifting, moral suasion and carry trade behavior can be eliminated by adjusting the preferential treatment of sovereign debt.

6. Investment consultants hiring and firing by pension funds
Aleksandar Andonov (University of Amsterdam), Matteo Bonetti (DNB) and Irina Stefanescu (Federal Reserve Board)

We investigate the hiring and dismissal of investment consultants in the context of U.S. pension funds. We document a substantial level of concentration among pension fund investment consultants. We find that pension funds replace general investment consultants after poor performance. Therefore, hiring is motivated by the desire to improve performance. However, we find little evidence that general investment consultants turnover is beneficial to pension funds' performance. Moreover, the hiring of a consultant specialised in alternative asset classes is related to the allocation of a pension fund in these asset classes.

7. Supervision of AI in the financial sector: towards a taxonomy AI risks
Frans van Bruggen (DNB, UU/NSOB) and Willem Heeringa (DNB)

In the fourth industrial revolution, AI applications are implemented in many sectors and disciplines. Alongside the sketched opportunities of AI, attention for the risks surrounding AI has also been increasing. Where AI's opportunities are mainly the domain of consultants and pure innovators (Martin, 2019), the risks for society and its public goals

should be an inherent part of proper regulation and supervision. Following the dominant problem-solving perspective of supervision, regulators should be aware of the these risks to public goals, in order to effectively mitigate them. It has been clear for several years that AI will have a significant impact on the stability of the (worldwide) financial system. The Dutch Central Bank (DNB), the Dutch prudential supervisor, is supervising the public value surrounding financial stability and solidity of financial institutions. Therefore DNB is increasingly looking at the risks of AI. Where many initiatives are already tackling the most obvious risks of AI, like fairness, transparency and privacy, not all these initiatives are making the threat to financial stability particularly clear. Also more 'complex' risks, like data governance, AI-application interactions, intelligence explosions and subgoals risks have received comparatively little attention. Therefore an underlying and comprehensive AI risk framework is needed, in order to make a proper risk analysis for the different sectors in the financial system. In this article we will propose a taxonomy of AI risks for financial supervision. Subsequently we will try to show ways how financial supervisors could mitigate these risks, by applying responsive regulation to the supervision of AI in the financial sector.

8. Solving bias in machine learning models using adversarial neural networks
Sayan Ray (DNB)
Machine learning models are increasingly being used in a variety of situations for data driven and automated decision making. Such models are also increasingly being used by financial institutions in various functions ranging from portfolio allocation and fraud detection to loan granting and credit scoring. However, along with its growing impact on society, machine learning has also been a source of controversy due to the fact that relatively high prediction accuracy of such models in classification problems sometimes comes at a cost of transparency. Additionally when training data sets contain undesirable biases (for example related to gender, race etc.) may inadvertently perpetuate or amplify such biases. In this study I propose to investigate the various approaches to measurement of bias towards certain sensitive attributes in predictions of a supervised learning model. Thereafter I will use these approaches to measure bias in loan acceptance decisions using 4 popular machine learning models – Linear Regression, Random Forests, XGBoost and Neural Networks. Lastly I propose a method to reduce this bias using adversarial neural network models.

Continued projects

1. The impact of central bank refinancing operations on bank equity offerings
Dimitris Mokas (European Banking Authority), Jan Kakes (DNB) and Massimo Giuliodori (University of Amsterdam)

We study how the Eurosystem's long-term refinancing operations affect the market response following banks' SEO announcements. Previous empirical studies have found that equity offering announcements have a lower impact on stock prices of banks relative to nonfinancial firms, because offerings are less prone to agency conflicts as capital regulation plays a bigger role. As the availability of attractive long-term central bank funding (TLTROs) makes it relatively easier for banks to improve their capital ratios, forced recapitalizations may become less likely. We investigate the hypothesis that, as a result of TLTRO funding, offering announcements are increasingly associated with agency problems and therefore cause stronger share price corrections. Further, we examine whether the price corrections depend on banks' (leverage, size, profitability) and characteristics of offerings (type, purpose).

2. Central bank digital currencies and financial stability: Market discipline in the era of digital money
Razvan Vlahu (DNB)

Central Bank Digital Currency (CBDC) is a highly debated topic. Various central banks are currently considering whether and how to introduce this new type of fiat money. The

introduction of a CBDC raises questions relating to, among others, the optimal design and potential consequences for financial stability. Some argue that under stress conditions, the presence of CBDC can increase the likelihood of bank runs. Concerns about a bank's health might encourage depositors to convert their money into CBDCs (since this digital money is backed up by sovereign credibility and thus risk-free). The financial stability implications of a CBDC would depend on depositors' behavior, which also depends on the specific attributes of the CBDC. This research project's main goal is to gain insights into the implications of the adoption of CBDC on financial stability. We answer the following questions: (1) How does the presence of CBDCs alter the nature of bank runs?, and (2) To what extent does the impact on bank deposits depend on the design features of a CBDC (such as interest rates and limits on convertibility)?

3. Collateral scarcity and reuse in the European repo market
Justus Inhoffen (DNB)

We study the effects of collateral scarcity on re-use in the European repo market. Using transaction data of the 53 largest dealer banks in the Eurozone, we estimate the daily bank- and security-specific reuse rate. We find that about 10% of the collateral obtained through reverse repo transactions is sold onwards. Regression results indicate that re-use increases as collateral becomes scarce through the ECB's asset purchasing programs.

4. Regulation, supranational bank supervision, and the corporate structure of foreign affiliates
Razvan Vlahu (DNB) and Natalya Martynova (Deutsche Bundesbank)

In the context of cross-border banking, we study how differences between home and host country regulatory arrangements, as well as the introduction of a supranational supervisor, affect the corporate structure of foreign affiliates. When going abroad, banks can operate as either a subsidiary or as a branch. Subsidiaries are separate legal entities regulated and supervised by host country's authorities, thus protected by limited liability. Branches are an integral part of the parent bank, enjoying no limits on the ability to transfer funds cross-border within the banking group. They are also subject to regulation and supervision on a consolidated basis in the home country. We show that when the host country's regulation allows for both structures, foreign banks may circumvent stricter regulation abroad and prefer to operate through a branch structure. We also show how the presence of a supranational supervisor, who limits the scope of "ring-fencing" arrangements in the host country, may affect the structure of foreign affiliate. By increasing subsidiaries' ability to easily move funds cross-border, while leaving the limited liability of the affiliate unaffected, a centralized supervision may increase the preference for a subsidiary structure.

5. The effect of the Dutch financial assessment framework on the mortgage investments of pension funds
Mauro Mastrogiacomo (DNB, VU Amsterdam, Netspar) and Yeorim Kim (VU Amsterdam)

We test whether prospective losses on the housing market induced moral hazard in the form of divorce. We study the Dutch context, where qualifying homeowners can buy into a guarantee scheme; essentially a lender's insurance against borrower default that transfers the risk to the public. Divorce is one of the major events following which the guarantor repays outstanding residual debt after (foreclosure) sale. We argue in this paper that divorce is endogenous to holding underwater mortgages, and hence constitutes a strategic choice. Using administrative data, we find a significant, 11% increase in the chance to divorce, causal to being insured. The identification relies on a regression discontinuity design, exploiting the fact that the insurance is only available for properties with values below a legislated threshold. The house price crisis (2008-2013) provides an unexpected shock in house values, leaving about 40% of owners with an underwater mortgage, and

with negative home equity of about €50.000 on average. Observationally similar couples above the threshold experienced significantly less often a divorce, relative to couples below the threshold.

6. The effect of introducing a Loan-to-Value limit on home ownership: Evidence for the Netherlands using (semi)parametric survival models
Cindy Biesenbeek (DNB), Mauro Mastrogiacomo (DNB, VU Amsterdam, Netspar), Rob Alessie (University of Groningen) and Jakob de Haan (University of Groningen)

We analyze the impact of the introduction of a Loan-to-Value (LTV) limit in The Netherlands on the probability for first time buyers to become homeowner using a duration model. Our research design is underpinned by a theoretical model that shows that a lower LTV limit results in suspending or renouncing home ownership, but only for liquidity constrained individuals. We use this finding to construct a treatment and control group with parents' financial wealth as a proxy for being liquidity constrained. We disentangle the effects of the LTV limit on the timing of the transition to first time home ownership from other market developments. We show that the effect of the LTV limit on this transition is small.

Theme 5. Trust

New projects

1. How can financial supervisors contribute to trust in financial institutions?

Carin van der Cruijsen (DNB), Maurice Doll (DNB) and Jakob de Haan (University of Groningen)

Consumers' trust in financial institutions is key because low trust may undermine financial stability and damage the financial services industry, which is detrimental for the well-functioning of the economy. Therefore, it is important for financial supervisors to gain better insight in the channels by which they are able to contribute to public trust in financial institutions. We focus on the Netherlands and use a consumer survey to research this topic.

2. Trust in financial institutions and central banks

Anna Samarina (DNB, European Central Bank) and Carin van der Cruijsen (DNB)

Trust in financial institutions is key because low trust may undermine financial stability and damage the financial services industry, which is detrimental for the well-functioning of the economy. Trust in central banks is also important. High trust comes with better-anchored consumer inflation expectations around the central bank’s price stability objective, which makes it easier to reach this objective. We discuss trust in financial institutions and trust in central banks and summarize research on their drivers and impact.

Theme 6. Sustainability

New projects

1. How climate change can affect the natural rate of interest
Francesco Paolo Mongelli (European Central Bank), Wolfgang Pointner (Oesterreichische Nationalbank) and Jan Willem van den End (DNB)

Climate change can affect the natural rate of interest (r*) through economic and financial channels. This could lower r* in scenarios with increasing physical damages and uncertainty, that reduce productivity growth and raise precautionary savings. In scenarios that assume climate-related innovations r* could positively be affected. Based on simulations for the euro area, with a structural model for the interest rate and a climate-economy model, we show that the downward effects of climate change on r* can be substantial, taking into account the large uncertainty about the outcomes. The downward pressure on r* will further challenge monetary policy in the long-run, by limiting its policy space. Fiscal policy has a pivotal role to raise r* by facilitating the transition to a carbon-neutral economy.

2. Households' interest rate expectations and behavior
Evangelos Charalambakis (Bank of Greece), Federica Teppa (DNB, Netspar) and Athanasios Tsiortas (European Central Bank)

The focus of this project is the analysis of interest rate expectations by the household sector in the Netherlands. The empirical analysis is based on novel survey data collected since April 2020 at a monthly frequency in the new ECB's Consumer Expectations Survey. The data allows to study how the consumers expect interest rates on savings as well as interest rates on mortgages to move in the next 12 months. The data also collects information on what the optimal interest rate movement would be for the economy as well as for the respondent's own finances. The data collected in the Netherlands will also be compared to those collected in the other EU countries also included in the survey. The study will investigate whether these expectations affect the household behavior in terms of consumption and saving.

3. A spatial portfolio approach to hedge physical risks in equity portfolios
Dirk Broeders (DNB, Maastricht University) and Flavio De Carolis (Maastricht University)

The focus of our research work is on exploiting Geographic Information Systems (GIS) and econometric methods to develop a dynamic portfolio strategy that is robust to climate hazards. Specific, we want to explore to which extent we can hedge the impact of physical risks in an equity portfolio using GIS. We choose equities and physical risks for several reasons. First, stocks are permanent claims on firms' cash-flows and their price should reflect the long-term risk faced by companies. Second, when climate hazards impact production facilities, they threaten companies' cashflows and thus their solvency. Third, access to GIS data is relatively new and may provide an information edge in assessing risks. The dynamic hedging strategy proposed in our work is based on a VAR including spatial, as well as temporal lags among a vector of stationary state variables. The development of climate change risk robust portfolio strategies is gaining momentum due to the increased climate change's awareness of institutional investors, such as pension funds, insurance companies and central banks.

4. The effect of labour market participation and education in credit access and approval during the covid-19 pandemic in Europe
Evangelos Charalambakis (Bank of Greece), Federica Teppa (DNB, Netspar) and Athanasios Tsiortas (European Central Bank)

We adopt the decomposition methodology à la Oaxaca (1973) and Blinder (1973) to identify and estimate the separate contributions of differences in parameters of (and in) individual demographic characteristics when accounting for mean differences in access to

credit markets and credit approval between the employed and the unemployed, as well as between the high educated and the low educated. The empirical analysis is based on novel microdata from the new ECB's Consumer Expectations Survey, a fully harmonized online survey measuring consumer expectations and behavior, covering the period April 2020 to December 2021.

5. Time series forecasting with local linear forests
Aishameriane Schmidt (DNB, Erasmus University Rotterdam)

This paper focuses on obtaining smoothed and interpretable time series predictions using random forests. Specifically, I propose to combine the local linear forest (LLF) from Friedberg et al (2020), which is a tree-based machine learning method, with the Shapley Additive explanation (SHAP) method from Lundberg and Lee (2017). I compared predictions obtained by the LLF to the traditional implementation of the Random Forest (RF) in simulated data and found out that for autoregressive signals, the apparent advantage that the LLF has on predicting linear models can be matched by the RF using a two-step forecasting procedure in which the dependent variable is first filtered using an AR model before estimating the forest. As an empirical application, I nowcast quarterly Dutch GDP from 1992 to 2018, comparing predictions from the LLF with the RF and other benchmarks. RF nowcasts and forecasts for 1 and 2 quarters ahead have lower error than competing models when averaging over all sample results. On the other hand, LLF can better forecast during high volatile periods. The SHAP decomposition in selected periods shows that the LLF puts more weight in survey variables, while RF predictions are based more on production and sales variables.

Continued projects

1. Optimal Collective Defined Contribution Pension Schemes
Ilja Boelaars (ING), Dirk Broeders (DNB, Maastricht University) and Annick van Ool (DNB)

Collective Defined Contribution (CDC) pension schemes become increasingly popular. In a CDC scheme, participants share the investment risks on their collective retirement savings by allowing pension benefits to fluctuate over time. From a sustainability perspective, CDC schemes should be designed in a fair and efficient way. Fairness requires that no ex-ante transfers of value occur between the generations in the scheme, and efficiency implies that individual participants have an optimal exposure to investment risks based on their preferences and life-cycle. We offer the design features for a general class of fair and efficient CDC schemes through the combination of a benefit adjustment mechanism and an investment policy, in the presence of equity market risk and interest rate risk.

2. Misallocation and productivity growth: a meta-analysis
Maurice Bun (DNB, University of Amsterdam) and Tolga Ozden (Bank of Canada)

In the last decades many countries experienced a slowdown in aggregate productivity growth. An important factor behind these declining productivity growth rates is misallocation of production factors. Recent studies have shown that empirical measures of misallocation based on the dispersion in marginal revenue products have increased over time within many countries. There are different sources of this observed misallocation, however, and there is in the literature no consensus about their relative impact on productivity growth. In this study we therefore conduct a meta-analysis of the extensive theoretical and empirical literature quantifying the productivity impact of the various origins of misallocation.

3. Does green trump home? An assessment of investors' relative preferences for green over domestic bonds.
Anouk Levels (DNB), Claudia Lambert (ECB) and Michael Wedow (ECB)

We investigate whether euro area investors have a preference for green bonds over domestic bonds. This question is relevant in the context of the European Commission's sustainable finance agenda. To realize Europe's climate ambitions, substantial private sector investments are needed. Resilient and well-integrated capital markets may help achieve these goals. Insights into investor's preference may inform policy discussions in the context of the CMU/Sustainable finance agenda.

4. Inequality and household financial decisions
Dimitris Georgarakos (ECB), Yuriy Gorodnichenko (University of California Berkeley), Olivier Coibion (University of Texas Austin) and Maarten van Rooij (DNB)

This project aims to better understand the effect of income and wealth inequality on household financial decisions (borrowing, housing investment and other spending categories) and the channels through which comparisons with peer groups affect household decisions. Also, we shed light on sustainability from the viewpoint of Dutch household perceptions about current levels of inequality.

5. Pricing the carbon factor for Europe's equity market
Kristy Jansen (DNB, Tilburg University), Rianne Luijendijk (DNB) and Sweder van Wijnbergen (DNB)

This paper uses firm specific CO2 emission data to augment the standard Fama-French three-factor model with a fourth "carbon factor". By constructing portfolios based on CO2 emissions we examine whether there is a systemic return from investing in a CO2 efficient European equity portfolio. In this way the paper will assess whether investors demand a carbon-specific risk premium as compensation for exposure to carbon risk. If there is no difference in pricing between CO2 intensive firms and low CO2 emitting firms, investors apparently do not value or possibly underestimate climate risk. If investors do price in a significant carbon factor this would have extensive consequences for the efficient allocation of investments and the cost of hedging carbon risk.

6. The employment effects of corporate income tax shocks: New evidence and some theory
Andrea Colciago (DNB), Vivien Lewis (Deutsche Bundesbank) and Branka Matyska (Leuven University)

We aim to assess whether cuts to corporate income tax rates can be a useful tool to boost job and business creation. We will provide empirical evidence concerning the effects of corporate tax income shock on firm creation (and destruction) and employment. Then we will estimate reduce forms effects using panel regressions estimated on US state data. We will then provide a DSGE model with search in the labour market and endogenous firms dynamics along the lines of Colciago and Rossi (2015), augmented with a fiscal side. The model will be aimed at addressing the main facts identified in the empirical analysis.

7. Financial literacy and pension expectations
Maarten van Rooij (DNB), Rob Alessie (University of Groningen) and Remko Struik (DNB)

A side-effect of low interest rates is that many pension funds are underfunded, have not been able to index the pensions for a number of years and may have to cut pensions when shortfalls do not recover. We investigate whether employees have updated their expectations regarding retirement age and replacement rate (both in terms of levels and uncertainty), also in view of the major policy changes since 2013 (gradual increase in statutory retirement age and reduced accrual rates). Moreover, we analyse whether the

updating of pension expectations is related to financial literacy or other personal characteristics.

8. Nowcasting Dutch GDP with machine learning methods

Andreas Pick (DNB, Erasmus University Rotterdam)

This paper compares the GDP nowcasting abilities of seven methods in a pseudo real-time setting. The analysis covers Dutch real GDP over the years 1992-2018 using a broad data set of monthly indicators and dives into the performance and interpretability of models based on factors, shrinkage, and ensemble learning. Combining the random forest and mixed-data sampling model yields the most precise approach to nowcast GDP. Inspection of the forecast contributions suggests that potential nonlinear and interaction effects might be driving the superior results of the random forest.

Theme 7. Payments and market infrastructures

New projects

1. Privacy in payments
Wilko Bolt (DNB) and Maarten van Oordt (VU Amsterdam)

The issue of privacy is attracting more and more attention in payments. Preserving one's privacy in payments is increasingly difficult in a rapidly digitalizing world. Privacy in payments is a feature inherent to the use of cash, but transactional usage of cash is in decline. Garratt and Van Oordt (2021) provide a theoretic model unveiling the potential adverse economic consequences of foregoing privacy in payments. Their analysis stresses a public good aspect of privacy: my own information and own choices may also reveal something about the behaviour of other individuals. Others have highlighted the role of personal privacy attitudes (Kahn, 2018). The idea of this paper is to test empirically the role of privacy attitudes for payment behavior by combining recent survey datasets.

2. Characteristics of Dutch cryptocurrency owners
Nils Brouwer (DNB) and Jakob de Haan (University of Groningen)

Using a Dutch household survey we want to get more insight into which individuals own crypto currencies and for which reason. We will look at various demographic characteristics (e.g. gender, age, education level), level of trust in the financial sector and central banks and their level of knowledge about cryptocurrency's. For this latter we look at the self-assed level of knowledge, knowledge about technical aspects of crypto currencies and knowledge about which crypto currencies were traded most. Next, we will try to gain more insights into why individuals (intend to) purchase crypto's: are individuals buying crypto's as an investment or as an alternative for fiat money? For this, we ask participants to rate which statements about reasons for (not) buying crypto's align most with their own motive.

3. Data sharing and the privacy paradox
Nicole Jonker (DNB) and Hans Brits (DNB)

We observe that, on the one hand, consumers indicate that they consider the privacy of their (financial) data to be very important and, on the other, that they share their personal data with third parties fairly easily. This is known as the privacy paradox. There appears to be a discrepancy between intentions and actual behavior, especially in online environments. The literature indicates several reasons for this phenomenon, such as little or no risk assessment and biased risk assessment. With PSD2 and open finance approaching, there is a danger that account holders will also share excessive financial data with third parties, and cannot foresee the risks for themselves and for society. The aim of this study is to examine to what extent Dutch households share financial data with third parties, whether their data sharing activities are in line with their intentions to share data, and which factors may explain discrepancies between intentions and actual behaviour, such as lack of risk assessments or biased risk assessments.

4. Bank digitalisation and household payment behavior
Justus Meyer (European Central Bank) and Federica Teppa (DNB, Netspar)

This paper focuses on the impact that the increasing digitalization in the banking sector has on households payment behavior and preferences. The empirical analysis, based on questions asked in the new ECB Consumer Expectations Survey, will shed light on the most preferred and most used transaction means, on the use of bank apps and on the availability of cashless and electronic payments for purchases purposes. The study will show how the Netherlands compares to the rest of the largest Euro area countries and will contribute to better understand whether the scarce use of digital forms of payment in

certain countries or for certain subgroups of the population is driven to demand side factors (preferences, low technological skills, and alike) or to supply side factors (lack of digital payment instruments offered by the financial institutions).

Continued projects

1. E-commerce: Use, growth and pricing
Wilko Bolt (DNB) and Bas Butler (DNB)

E-commerce is rapidly growing. Buying online represents a technology that will fundamentally change the way industries operate. Although E-commerce sales remain a smaller percentage of overall sales than "brick-and-mortar", yet the percentage continues to increase at a (much) faster rate than overall sales. Who are the online users, how do they pay and what preferences do they have? What does it mean for market structure, competition and its effect on product pricing? How do network effects come into play? Using recent Dutch survey results ('two waves') on E-commerce this paper tries to empirically assess above questions by applying multivariate logit/probit regression models, identifying demand and preference characteristics and its potential effect on payment use, production cost, price levels and inflation ("the Amazon effect").

2. Virtual currencies: Dynamics and monetary aspects
Wilko Bolt (DNB) and Maarten van Oordt (VU Amsterdam)

Bitcoin was launched in 2009 and has recently attracted much attention from economists, financial media, and even governments. Its increased attention was fueled by the sudden "explosion" and volatility in the exchange rate of Bitcoin by the end of 2013. Can economic theory help explaining these extreme price movements and its dynamics, and does virtual currency pose a threat or an opportunity for monetary policy? As a follow-up on Bolt and van Oordt (2020), this research project tries to further assess the dynamics, 'bubble properties', and monetary aspects of virtual currency.

3. **Contactless payments, the pain of paying, and financial troubles**
Marie-Claire Broekhoff (DNB) and Carin van der Cruijsen (DNB)

The Covid-19 pandemic has drastically changed consumer payment behaviour. It has boosted the share of contactless payments at the point-of-sale. Contactless payments are a quick and user-friendly way to pay. However, given the speed of paying a contactless payment may feel less like a real payment than a cash or traditional debit card payment; the pain of paying may be lower. This may increase the likelihood of excessive spending. We collect consumer survey data to gain insight into payment behaviour, the pain of paying and financial troubles. Thereby, we examine the role of age and other personal characteristics.

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