DNB Research program 2017

1. Monetary and fiscal policy, business cycles and price stability

1. Inflation expectations across the euro area (started in 2016)
Eric Bartelsman (Free University Amsterdam, Tinbergen Institute), Dennis Bonam, Manu de Veirman

When inflation expectations in a monetary union are different across member states, real interest rate differentials might arise which could fuel macroeconomic imbalances. Our aim is to examine the degree of dispersion of inflation expectations across euro area countries and the factors that drive dispersion. We also examine whether this dispersion (if any) is similar across the US.

2. Virtual currencies: dynamics and monetary aspects
Wilko Bolt, Maarten van Oordt (Bank of Canada)

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? Building on Bolt and van Oordt (2016), this research project tries to further assess the dynamics and monetary aspects of virtual currency.

3. Fiscal policy and sovereign risk premia under monetary union
Dennis Bonam

Using a New Keynesian model, we examine the implications of sovereign risk premia for fiscal policy under monetary union. We find that countercyclical policies at the national level can stabilize macroeconomic conditions and enhance welfare when member states are relatively small and price rigidities strong. However, when further increases in sovereign debt are perceived to be unsustainable and elevate sovereign risk premia, fiscal expansions become destabilizing whereas pro-cyclical policies maximize welfare. Furthermore, government spending multipliers are typically lower in the presence of sovereign risk premia, especially when monetary policymakers (are forced to) keep interest rates constant.

4. The effects of fiscal policy at the zero lower bound
Dennis Bonam, Jakob de Haan, Beau Soederhuizen (Nyenrode Business University)

We estimate the effects of government consumption and investment shocks for a panel of advanced economies. Prolonged episodes of low interest rates are identified to examine the effects of the zero lower bound on fiscal multipliers. We find that both the cumulative government consumption and investment multipliers are significantly higher, and exceed unity, when interest rates are persistently low than when they are not. A standard New Keynesian model supports the empirical results, yet also shows that government investment multipliers can turn negative when the ZLB is binding due to a reduction in marginal costs and inflation, and subsequently higher real interest rates.

5. Heterogeneous expectations and macroeconomic imbalances in a monetary union
Dennis Bonam, Gavin Goy (University of Amsterdam)

The quasi-fixed nominal interest rate across countries under monetary union may give rise to divergent economic dynamics due to cross-country inflation differentials and a pro-cyclical real interest rate channel. Over time, endogenous adjustment of the real exchange rate helps stabilize economic conditions. However, the adjustment process might be prolonged if expectations differ across countries. We propose a New Keynesian model where agents form expectations that are biased towards domestic information. We show that such home bias in expectations strengthens the real interest rate channel, which has important implications for macroeconomic imbalances and monetary policy in a monetary union.

6. *Deleveraging, pessimistic beliefs and quantitative easing*
Dennis Bonam, Gavin Goy (University of Amsterdam)

Our aim is to assess the relative strengths of various transmission channels of quantitative easing (e.g. portfolio-rebalancing, risk-seeking, signaling, real exchange rate) in times when agents (households and firms) face financial constraints and deflationary shocks provoke pessimistic beliefs about future economic conditions. To this end, we apply a medium-sized two-country dynamic stochastic general equilibrium (DSGE) model with market segmentation and a rich set of nominal and real rigidities. Unlike most DSGE models, expectations are not rational, yet formed adaptively using a recursive least-squares algorithm. The combination of tightened financial constraints and pessimistic beliefs, which characterized the Great Recession, may cause agents to engage in deleveraging, which in turn could prolong the recessionary state. This amplification mechanism has thus far received little attention in recent research on the effects of QE.

7. Fiscal multipliers at the extensive margin (started in 2015)
Andrea Colciago, Vivien Lewis (University of Leuven), Lorenza Rossi (University of Pavia)

We provide VAR evidence concerning the joint effect of a Government Spending and a Dividend income tax shock on unemployment and firms' creation (the extensive margin of investment) in the U.S. We provide a DSGE model consistent with the facts we uncover.

8. Who creates jobs over the business cycle? Part 2
Andrea Colciago, Antonella Trigari

Part one was concerned with establishing some stylized facts about job creation and destruction by different categories of firms in terms of age and size using US data. In the next step, we will provide a DSGE model in line with the facts. This will also allow carrying out policy analysis. The model will be characterized by heterogeneous firms along the two dimensions mentioned above.

9. Measuring asymmetry in the macroeconomic effects of changes in regulatory loan-to-value limits (started in 2016)
Jasper de Jong, Emmanuel de Veirman

We propose a methodology for estimating how the introduction of a maximum for loan-to-value ratios on mortgage loans, or changes in that maximum, affect the macro economy. By means of cross-sectional data on household loan-to-value ratios, we translate a desired path for the loan-to-value limit into a succession of shocks to the average loan-to-value ratio. We then track the dynamic response of house prices and consumption to these shocks. In general, the effect of changes in the loan-to-value limit is non-linear since the fraction of households for which the limit binds increases as the limit falls. We illustrate our approach for the Netherlands, where a loan-to-value limit has been in place since 2012.

10. Public capital in the 21st century: As productive as ever?
Jasper de Jong, Marien Ferdinandusse (ECB), Josip Funda (HNB)

In the fiscal adjustment process following the global financial crisis and the euro area sovereign debt crisis, public investments were severely reduced in many countries. How harmful is this for growth perspectives? We expand time series on public capital stocks for 20 OECD countries as constructed by Kamps (2006) and estimate country-specific recursive VARs. Results show that the effect of public capital shocks on economic growth has not increased in general, although results differ widely between countries. This suggests that the current level of public investments generally does not pose an immediate threat to potential output. We furthermore provide some tentative evidence of positive spillovers of public capital shocks between European countries.

11. Read the news carefully: The effect of consolidation efforts on Dutch sovereign spreads
Jasper de Jong, Rebekka Tselms

In response to the rapid deterioration of the budget balance following the global financial crisis and the euro crisis, the Dutch government implemented multiple large consolidation packages. Applying an event study methodology, we intend to assess whether consolidation measures have - in the eyes of investors - contributed to enhancing the government's solvency.

12. Unconventional monetary policy and market expectations: some evidence for the euro area
Leo de Haan, Jan Willem van den End

An unintended consequence of unconventional monetary policy measures may be that they lead to market dominance over monetary dominance. Since unconventional measures such as QE were introduced by the ECB, the timing of such measures sometimes gives the impression that monetary policy reacts to market expectations instead of the other way around. In this paper, we therefore search for empirical evidence of market dominance over monetary dominance. We use weekly data for 2007-2016 and employ rolling Granger causality tests, regression analysis and VAR models with fixed and rolling window coefficients.

13. Lending shocks and macroeconomic stability (started in 2015)
Emmanuel de Veirman

In a theoretical model calibrated to the US economy, I investigate the macroeconomic effects of changes in downpayment requirements on mortgage loans. A tightening in downpayment requirements weakens the collateral effect, and thereby dampens the macroeconomic effects of monetary policy and housing demand shocks. The lending shock itself is amplified to a lesser extent when downpayment requirements are tight, implying that a change in downpayment requirements induces less short-run volatility when downpayment requirements are tight at the outset.

14. Estimating and interpreting financial cycles
Gabriele Galati, Irma Hindrayanto, Siem Jan Koopman (Free University Amsterdam)

The concept of financial cycle plays an important role in the current debate on how to increase the resilience of the financial system and dampen its procyclicality. The financial cycle captures systematic patterns in the financial system that can have important macroeconomic consequences. In recent years, empirical research has documented time-series patterns in financial variables – mainly credit growth, leverage, and real estate prices – around financial crises. There is however no consensus yet on how to measure the financial cycle nor on how to interpret different patterns that have been found over time and across countries. This paper reviews this growing literature and points to interesting avenues for future research. It takes stock of alternative estimation methods and their challenges, discusses issues related to the interpretation of the main empirical findings, and reviews the most important policy implications.

15. Formation of inflation expectations – new insights from heterogeneity in a high-frequency survey
(started in 2014)
Gabriele Galati, Richhild Moessner (BIS)

We analyse the mechanism through which inflation expectations are formed by evaluating results from a survey conducted from July 2010 through December 2014. Participants in this survey answered a weekly questionnaire about their expectations of euro area HICP inflation at one-, two- and ten-year horizons. Participants received common information sets with data relevant to euro area inflation. We examine alternative expectation formation rules and test for the role of the ECB's definition of price stability as a focal point. We also exploit information on questions on the entire of distribution of inflation expectations to examine whether individual uncertainty differs from cross-sectional dispersion and time series variability of expectations.

16. Euro area contagion and the role of the OMT
Niels Gilbert

We construct a narrative news database to investigate contagion during the eurocrisis. The focus is both on contagion between the crisis countries, and on contagion from the crisis countries to other euro area member states. We differentiate between news about the economic and political situation in the crisis countries themselves, and news about future bailouts. We then investigate how successful ECB policy, and in particular the OMT, has been in eliminating contagion, and if there is a price in terms of reduced market discipline.

17. Sectoral allocation and macroeconomic imbalances in EMU (started in 2016)
Niels Gilbert, Sebastiaan Pool

In the decade following the introduction of the euro, many Southern EMU members experienced sizeable capital inflows. We document how, instead of contributing to convergence, these flows mainly fuelled growth of the non-tradable sectors. We rationalize these developments using a tractable two-sector, two region ('North' and 'South') model of a monetary union. We show how the sharp fall in Southern interest rates that occurred in the run-up to EMU, leads to a consumption boom, wage growth, growth of the non-tradable sector, and a deteriorating external position. In the North, an opposite process occurs. As such, both real exchange rates and external positions of the two regions diverge. Including a third country with a flexible exchange rate vis-à-vis the euro amplifies the effects of monetary integration in the South, while dampening them in the North. Using a panel-BVAR, we confirm empirically that the euro area countries experiencing a fall in interest rates relative to the euro area average, experienced faster growth of the non-tradable sector and a deteriorating current account balance. We investigate various policy reforms to speed up the necessary rebalancing process. A deepening of the European market shows most promise, boosting GDP growth while facilitating a rebalancing towards tradables.

18. Wage dynamics after the crisis (started in 2015)
Marco Hoeberichts

Using the results from the third wave of the Wage Dynamics Questionnaire, we will address a selection of issues regarding wage dynamics, possibly relating frictions in the labour market to financial frictions.

19. Household inflation expectations in a context of low inflation (started in 2015)
David-Jan Jansen, Matthias Neuenkirch (University of Trier), Edith Neuenkirch (University of Marburg)

We use the DNB Household Survey to further understand household inflation expectations. In particular, we will address the role of inflation perceptions and media usage in a context of low inflation.

20. Is fiscal policy in the euro area non-Ricardian?
Nikki Panjer (University of Groningen), Leo de Haan, Jan Jacobs (University of Groningen)

According to the Fiscal Theory of the Price Level, evidence in favor of a non-Ricardian regime means that monetary policy plays a minor role in the determination of prices and fiscal policy has to play a larger role, the more so if monetary policy is at the zero lower bound. We empirically determine whether a Ricardian or a non-Ricardian regime is more plausible for fiscal policy in the euro area, following the research strategy of Canzoneri, Cumby, and Diba (2001). A bivariate Vector Autoregressive (VAR) model, including the primary surplus and the government debt, is estimated for the period 1980q2-2013q4.

2. Financial markets, financial stability and macro-prudential supervision

1. Impact of bank and capital market financing on growth and stability: a literature review
Jaap Bikker, Emiel van Bezooijen (Utrecht University)

Allen and Gale (2001) compare market-based and bank-based systems in terms of their ability to (1) promote cooperative behavior mitigating adverse selection and moral hazard problems, (2) stimulate growth, (3) allow both intertemporal and cross-sectional risk sharing, and their role in (4) the acquisition and use of information to allocate resources efficiently. In addition, Allen and Gale (2001) discuss several studies on the importance of law and corporate governance. We will perform an extensive review of the literature on the difference between both systems in stimulating growth and stability.

2. The impact of the ECB asset purchases on the European bond market structure: Granular evidence on ownership concentration
Martijn Boermans

We study the effects of the ECB public purchase program on the micro market structure of the eligible bonds. Using securities holdings information we assess the changes in ownership concentration of individual bonds compared to a benchmark. We test the predictions of two theories and evaluate the extent of distortionary effects on the bond market structure.

3. European CoCo issuances: What choices do banks face?
Martijn Boermans, Tomislav Ladika (University of Amsterdam), Natalya Martinova (University of Amsterdam), Sweder van Wijnbergen

This paper assesses the choices banks face when they issue contingent convertible debt instruments. Building on an emerging literature on the theoretical mechanisms we develop a simple model of the choice not to issue versus issuing CoCos with certain characteristics. To test the predications of the model we construct a granular CoCos database focusing on individual bonds. The results are important for academics to better understand the trade-offs banks face when issuance CoCos as the empirical literature is still in its infancy. The outcomes are relevant to regulators and policy makers as they inform them about the underlying trends in the CoCo markets.

4. The liquidity of financial instruments (started in 2015)
Clemens Bonner, Iman van Lelyveld

Liquidity has come to fore, receiving attention from both academics and regulators alike. The latter have implemented both a Liquidity Coverage Ratio (LCR) and a Net Stable Funding Ratio (NSFR) to reduce liquidity risks. The key underlying notion is that to cover (potential) outflows, a firm should have sufficient liquid assets. The aim of this paper is to investigate how banks' funding profiles have evolved in recent years in response to an almost complete collapse of unsecured funding markets and the transition to the new regulatory framework. One primary data source of this paper are the MiFID transaction reports obtained from the Netherlands Authority for the Financial Markets (AFM). As such, the MiFID database is the most comprehensive dataset on market transactions in the EU. Along with many other data fields, each transaction in the dataset includes the international securities identification number (ISIN) of the traded security, the two trading counterparts, volume, time to maturity, the exact time as well as whether the reporting institution acted as a buyer or a seller. The MiFID data will be augmented with other data available at DNB, e.g. covering the unsecured interbank market.

5. Procyclicality in insurance companies' asset allocation
Stijn Claessens (Federal Reserve Board), Robert Vermeulen

We study the effects of changes in the liability discount rate on insurance companies' asset allocations. As prudent long-term asset-liability investors the market value of insurer's liabilities changes substantially when long term interest rates change. These changes have an effect on the solvency of insurers when there is a duration gap between assets and liabilities. By using data from 2009-2016 we investigate how asset allocations are affected by changes in discount rates and duration gaps.

6. Measuring systemic risk in OTC-derivatives markets (started in 2015)
Anouk Levels, Svetlana Borovkova

The OTC-derivatives reforms aim to reduce systemic risk by increasing transparency and mandating central clearing for some types of derivatives. However, while central clearing of derivatives reduces counterparty credit risk amongst market participants, new risk will emerge. These include liquidity risk as a result of increased collateral demand and concentration of risk exposures with the central clearing houses (CCPs) and general clearing members. The aim of the research project is to develop a formal framework that can be used to analyse risks in the derivatives market for Dutch financial institutions. A first goal is to obtain the network for Dutch financial institutions and to analyse how shocks in the underlying of derivatives spread through the system. The basis framework can later be extended to study questions such as: (i) Do alternative CCP requirements (policy measures) alter contagion in the network? (ii) Do pension funds need access to central bank liquidity in the light of central clearing? (iii) Do alternative network structures alter contagion in the network?

7. Do shocks to financial intermediary capital move financial markets?
Mark Mink, Iman van Lelyveld, Rodney Ramcharan (USC, Price School of Public Policy)

One of the key objectives of financial regulation and supervision is to ensure that financial intermediaries are adequately capitalized. The recent financial crisis has amply illustrated the need for such regulation, as a sudden worsening of financial intermediaries´ capital positions can destabilize financial markets as well as the real economy. In this research, we exploit the Securities Holding Statistics (SHS), a large and granular database on the securities holdings of euro area financial intermediaries to examine how shocks to these intermediaries' capital positions spill over into financial markets. The outcomes of this research can contribute to financial stability and regulation policies, and to our understanding of the link between financial intermediary capitalization and asset price formation in financial markets.

8. Bank relationships after foreign takeover
Steven Poelhekke, Razvan Vlahu, Vadym Volosovych (Erasmus University Rotterdam)

This empirical study will investigate the impact of foreign acquisitions on funding of acquired non-financial companies. Put in different words, we will try to assess whether non-financial companies who rely on funding from banks, change (completely/partially) their borrowing counterparty upon being acquired by a foreign entity. Do such firms rely on (multinational) banks for their funding and other bank services, or do they adopt the bank relationships of their new foreign owners? Do they keep both relationships and split bank services along particular lines? The latter may have become more likely now that firms have reduced their international scope by closing or selling foreign offices (notably ABN AMRO). These questions further help to shed light on the importance of a banking system with home country multinational banks, versus a banking system with smaller domestic banks with a national scope and a set of local offices of *foreign* multinational banks.

9. Shadow banking and macroeconomic stability (started in 2015)
Sebastiaan Pool

In this paper I build a model placing the financial sector at the heart of the economic framework, i.e. the model is built around the concept of credit. The critical component of the model is the endogenous build-up of systematic risk as proclaimed by Minsky (1986). While the increase in leverage dwindles down margins in the financial sector, credit for mortgages rather than productive capital increases the dependence of the financial sector on a low inflation rate, low policy rates, and steady growth rate. In the model I will show that an episode of tranquility results in an unstable financial sector, which collapses when the realized state deviates (slightly) from past expectations.

10. The impact of carbon pricing on securities values: an industry level approach
Henk Jan Reinders, Jaap Bikker

Carbon pricing may cause substantial shifts in the costs and revenues of firms in a broad range of industries. A currently evolving strand of research looks into the risks of carbon pricing to securities values (*e.g.* bonds and equity) held by financial institutions. A typical approach taken in these papers is to gauge the vulnerability of firms and industries by looking at their carbon intensity. Simply knowing the carbon intensity of a firm or industry does however not seem to be enough to determine the impact of carbon prices on the value of its securities. At the firm level, a relevant mediating factor seems to be whether the firm is positioned well within an industry to cope with higher carbon prices (*e.g.* its energy efficiency and its competitive advantage in adapting itself to a new environment). At an industry level, there are likely at least two factors that mediate the effect of carbon pricing on the value of the industry. These are (i) the extent to which higher input prices can be passed on to consumers (and to what extent market size changes as a result) and (ii) to what extent industries are capable of substituting dirty inputs for clean ones. This research focuses on the impact of carbon pricing on securities values and the role of industry level factors. We use data on financial sector assets (classified into industries using NACE Rev. 2 and/or NAICS) and investigate the responsiveness of their price to cost shocks, such as price changes in emission rights traded within the EU Emissions Trading System (EU ETS). We perform our estimations at the industry level (using a panel of industries over time).

11. Towards a sustainable energy transition in the wake of climate change
Olaf Sleijpen, Martijn Regelink, Timo Marquardt, Alexander Wisse (University of Maastricht), Elias Sobotka (University of Maastricht), Nasser Al-Mohannadi (TAMU), Patrick Linke (TAMU), Dhabia Al-Mohannadi (TAMU), Mike Bowman (TAMU).

Climate change is a threatening macro trend that is expected to have severe negative consequences for the world population and economy. Recent studies highlight financial markets could also be affected by climate change through two types of risks. First, the physical risks associated with an increase in natural catastrophes may have a negative impact on (re-)insurers' liabilities, as well as assets held by financial firms vulnerable to the effects of climate change. Second, transition risks arising from harsh anti-climate-change policy implementations, disruptive energy technologies and changing social sentiment can trigger sharp devaluations of carbon intensive assets held by banks and institutional investors. Recent scenario studies highlight the urgent need for a global carbon transition to meet the now ratified Paris agreement and limit global warming. This project develops a new carbon transition model that eases the practical implementation of transition targets for the Netherlands and supports the mitigation of future climate change related side effects for the Dutch financial sector.

12. Sharing house price risk
Dorinth van Dijk, Martijn Droës (University of Amsterdam), Marc Francke (University of Amsterdam)

This paper examines to what extent the distribution of housing returns (standard deviation) changes by portfolio size and the geographical scale of the portfolio. We use a rich source of data covering the majority of housing transactions in the Netherlands. We use a random and non-random matching procedure. We show that the distribution (standard deviation) of housing returns collapses quite quickly with portfolio size. Most of the collapse is already achieved with a portfolio size of 10 houses or less. Moreover, portfolio's based on matching within regions do not have a much higher standard deviation. The results in this paper imply that a fully-fledged financial market (by geographical scale or portfolio size) based on house prices is not necessary to reap the majority of the diversification benefits present in housing markets.

13. Creating constant quality liquidity indices in thin markets
Dorinth van Dijk

Market liquidity is an important measure used by researchers, policymakers, and practitioners to infer the current market situation. For example, many authors provide evidence that developments of market liquidity foreshadow price developments. Policymakers look at market liquidity to identify hot markets and brokers use liquidity to assess the market situation. Most institutions use the average time on market as market indicator. The average, however, might provide a misleading view regarding actual market liquidity. Currently, there is no measure that creates an operational measure for constant quality market liquidity specifically for thin markets. Analogous to existing regional constant quality house price indices, I propose to create regional constant quality liquidity indices.

14. Credit, price and wage dynamics in the housing market
Dorint van Dijk, Alex van de Minne (MIT), Marc Francke (University of Amsterdam)

We examine the dynamics and causality between credit, income, interest rate spreads, and the value of the collateral (houses) in the Netherlands on a regional scale. We include an exogenous shock in credit conditions and find that the easing of credit standards between 2005 and 2008 has led to an increase in LTI and LTV ratios of 11% and 8%, respectively. The tightening of the standards between 2009 and 2014 is related to a decrease of 13.4% in LTIs and 10.8% in LTVs. Moreover, the effects are not equal across regions: LTI ratios are more sensitive in more supply constrained and expensive regions. Regional differences in effects on LTV are less pronounced. This is the result of the tax deductibility of interest payments, which incentives high LTVs nationwide. Finally, contrary to the US, we find that Dutch MFIs did not lend to lower income households when credit standards tightened.

3. Micro-prudential supervision and conduct of financial institutions

1. Crowded trades, shared portfolios and price instability (started in 2016)*
Assaf Almog (Lorentz Leiden), Diego Garlaschelli (Lorentz Leiden), Iman van Lelyveld

Crowded trades by identically trading peers might influence asset prices dynamics in the aggregate, possibly fostering systemic risks. However, due to limited data such effects have not yet been investigated. We will examine the effects of market clustering – segregating stock markets in secluded submarkets – on price stability applying complex network methods to compute a measure of market clustering. We will develop a method to empirically investigate market microstructure patterns using large-scale granular trading data (80 million individual transactions collected under MiFID), which can be applied to a wide range of trading patterns. We will then investigate the relation between market clustering and price stability.

2. Risk indicators in financial market infrastructures: TARGET2
Ron Berndsen, Ronald Heijmans

This paper aims to identify (quantitative) risks in financial market infrastructures (FMIs), which are inspired by the Principles for Financial Market Infrastructures (CPSS (2012)). We use high frequency transaction data to develop indicators that provide information on a specific risk listed in these PFMIs. As a proof of concept we use TARGET2 transaction level data. We start the development on risk indicators for 1) operational, 2) liquidity and 3) FMI link risks. We propose a traffic light solution for the signalling of potential stress or significant deviation from a defined normal situation. The outcome of this paper can be used by overseers and operators of FMIs and by financial stability experts.

3. Risk indicators in financial market infrastructures: CCPs
Ron Berndsen, Alinda Heemskerk, Ronald Heijmans

This paper identifies (quantitative) risks in financial market infrastructures (FMIs). We do this by converting transaction level data into an indicator that provides information on a specific risk listed in the PFMIs. We use detailed data of EuroCCP to set up a framework to identify risks for CCPs in general. The methodology is in line with Berndsen and Heijmans (in progress).

4. Performance of sustainable banks in Europe
Jaap Bikker, Bert Scholtens (University of Groningen), Laura Spierdijk (University of Groningen)

Banks play an important role in the transition towards a more sustainable economy. They particularly have influence by granting credit to green enterprises. Further they invest in green bonds or shares, either for their own risk or for participants in green investment funds they manage. For supervision and the society, the performance of these sustainable institutions is important. What are the returns and risks of green banks? And how do these banks perform in terms of competition, efficiency and solvency? This research focuses on two issues. First, we measure the degree these banks contribute to green economic activities by investigating their lending and investment portfolios. Second, we analyze the performance of their business operations in terms of returns and risks, efficiency and competition.

5. Carbon footprints and pension funds' portfolio investment trade-off
Martijn Boermans, Rients Galema (Utrecht University)

In this study we empirically test how Dutch pension funds allocate their stocks towards firms with high and low carbon footprints. We analyze the determinants and trade-offs pension funds face when deciding to investment in companies with lower carbon emissions. We build a new harmonized measure of carbon footprints using unique information from portfolio investments. The results have important ramifications for practitioners and supervisors who value the transition to a low carbon economy and aim to promote a more sustainable financial sector.

6. Early warning and forecasting performance of HAMs in housing markets (started in 2015)
Wilko Bolt, Cees Diks (CeNDEF, University of Amsterdam), Cars Hommes (CeNDEF, University of Amsterdam), Marco van der Leij (CeNDEF, University of Amsterdam)

Based on DNB WP 2014 2014-450, we apply a nonlinear endogenous switching model of heterogeneous expectations to housing price data, where agents switch between a mean-reverting fundamental view and a trend-extrapolating forecasting rule, based upon their relative profitability. We would like to evaluate this so-called HAM (i.e. heterogeneous agent model) in terms of forecasting performance (HAMs versus linear models) and, based on these results and robustness, assess how the model can be used for early warning purposes. In addition, we would like to extend the model accounting for a number of other variables, including interest rate costs (mortgage costs) as well institutional aspects that dominate the differences between countries.

7. Liquidity regulation and monetary policy operations in normal times (started in 2016)
Clemens Bonner, Iman van Lelyveld

In response to the 2007-08 financial crisis the Basel Committee on Banking Supervision has updated the regulatory framework. Besides new rules for capital, the framework also introduces a short-term and a long-term liquidity requirement (LCR, NSFR). Pointing to the reduced risk of fire sales and bank runs, several studies have provided a rationale for such liquidity regulation. Some have pointed to potential harmful side effects related to the specific design of the LCR or liquidity regulation in general. Especially the impact on the functioning of interbank money markets and monetary policy implementation has been subject to discussions. This paper empirically analyses the impact of liquidity regulation on interbank money markets and monetary policy implementation. This analysis is based on unique data on the Dutch quantitative liquidity requirement 8028 in combination with data on banks' lending and borrowing behaviour in the Dutch unsecured interbank money market and banks' lending to non-financial institutions.

8. Network models of derivatives markets and the consequences of central clearing (started in 2016)
Svetlana Borovkova (Free University Amsterdam), Robert Jan van Leijden, Anouk Levels

We will continue with the network-based investigation of the stylized derivatives market and examine the consequences of the central clearing on liquidity, contagion, asset fire sales, as well as on different types of financial institutions, focusing in particular on pension funds, insurance companies and other non-core financial institutions. Furthermore, we will separately examine the liquidity situation and risk measures associated with clearing houses, such as the structure of the default waterfall and models for initial margins.

9. Pension funds and variations in the illiquidity premium (started in 2016)
Dirk Broeders, Kristy Jansen (Netspar, Tilburg University), Theo Nijman (Netspar, Tilburg University), Bas Werker (Netspar, Tilburg University)

Pension funds are long horizon investors and are among the most qualified investors to profit from variations in liquidity premiums over time. The main contribution of this paper is to analyze if pension funds are able to benefit from the illiquidity premium in down markets. We use different liquidity measures and proxies for market liquidity (*e.g.*, a measure of down markets). We also look at potential constraints that can restrict pension funds' investment behavior. The potential outcome of this paper is to better understand a pension funds' trading strategy towards alternative and illiquid investments during a period of financial market stress.

10. A return analysis of pension fund investment portfolios (started in 2016)
Dirk Broeders, Arco van Oord, David Rijsbergen

The investment performance of pension funds influences general welfare, as they are responsible for maintaining the standard-of-living of beneficiaries after retirement. Poor investment returns can significantly impact the wealth and consumption of beneficiaries. From the academic literature, several points of interest regarding pension fund performance stand out. For one, there appears to be a strong focus on equity investments. This can largely be attributed to the absence of sufficient data on investment performance for other asset classes. A second point of interest is that the academic literature tends to focus on the performance of U.S. pension funds. Again, this appears related to the availability of data. As a result, remarkably little is known about the investment performance of European pension funds. The main contribution of this paper is to employ an exclusive pension fund database to provide a comprehensive overview of the investment performance of Dutch pension funds for 2012 and 2013. Using a unique dataset, we provide a comprehensive and detailed examination of the investment performance of Dutch pension funds. Our dataset is free from self-reporting biases, and contains detailed information on pension fund-specific returns and benchmarks for a distinct set of asset classes. The database covers unique data for approximately 200 pension funds and is highly detailed. For one, the database provides the returns per pension fund for 6 different asset classes (i.e. equity, fixed income, real estate, commodities, private equity and hedge funds).

11. Banks' net interest income in a low interest rate environment
Raymond Chaudron, Leo de Haan, Marco Hoeberichts

Recent research – both on Dutch banks (Chaudron, 2016) and on banks in other countries (e.g., Lucas, Schaumburg and Schwaab, 2016) – has shown that net interest income is not affected much by a flattening of the yield curve. This study investigates for 40 Dutch banks which factors are important in this regard, focusing on characteristics of the Dutch banking sector (e.g., market power, capitalization, credit risk, other sources of income such as fees and commissions).

12. The impact of sovereign ratings and the ECB's purchases of public debt on cross-border holdings of euro area sovereign debt
Leo de Haan, Robert Vermeulen

During the euro area sovereign debt crisis, there were frequent and large downgrades of euro area countries' sovereign debt, especially for the GIIPS countries. These downgrades led to huge shifts in cross-border holdings of euro area sovereign debt. The markets calmed after Mario Draghi's famous "Whatever it takes" speech. With the introduction of the Public Sector Purchase Program (PSPP) by the ECB early 2015, the ECB purchases euro sovereign debt, as part of its Quantitative Easing operations. Using detailed data for the euro area, we investigate the impact of rating changes and Quantitative Easing on cross-border euro sovereign bond holdings of euro area investors. We are able to distinguish investors by country of residence and sector, i.e. banks, insurance companies, pension funds, investment funds and households. The sample period is 2009-2015 and the frequency is quarterly.

13. The resilience of young firms during the financial crisis (started in 2016)
Ralph de Haas (European Bank for Reconstruction and Development), Neeltje van Horen (Bank of England), Vincent Sterk (University College London), Jasper de Winter

The financial crisis of 2008 and the subsequent recession triggered a crunch in firm credit and a slump in aggregate demand. One might expect that most vulnerable to these shocks were the firms that were young, highly leveraged and cash-constrained. This is particularly concerning as high-growth, young firms are known to be a key contributor to aggregate job creation. Using a unique administrative dataset on the complete population of Dutch firms we follow firms that were established just prior to the crisis, and contrast their performance to firms that grew up during more tranquil times. Importantly, we observe not only their output, productivity and employment, but also their balance sheets. We use this information to investigate how the pre-crisis balance-sheet structure impacted on firm growth, productivity and the probability of surviving the crisis.

14. Monetary spillovers across borders: international lending of Dutch banks, insurers and pension funds
Patty Duijm, Clemens Bonner, Leo de Haan, Jakob de Haan, Jon Frost

Both conventional and unconventional monetary policies can influence the foreign activities of financial institutions. As part of a broader project under the International Banking Research Network (IBRN), we examine the relationship between policy interest rates in the Netherlands and in host countries on the international lending of Dutch banks, insurers and pension funds. Key questions include how monetary policy is transmitted across borders, which channels are the most important in explaining such spillovers and whether banks are "special" in the sense that their behaviour is different from other financial institutions.

15. Identifying risks in Central Counterparties
Alinda Heemskerk, Ronald Heijmans, Tatu Laine (Bank of Finland), Kasperi Korpinen (Bank of Finland)

This paper shows how the robustness of a central counterparty (CCP) can be measured. To measure this we create a BoF-PSS2 simulator based CCP simulation tool that is based on the tool. We develop a method to measure whether a CCP lives up to the PFMI requirement with respect to the failure of large banks (2 large banks should be able to fail). Furthermore, we measure the effectiveness of the netting algorithm. We investigate four different scenarios: 3 theoretical market types (homogeneous, linear and exponential in terms of the size of the clearing members) and 1 realistic case based on real data. Furthermore it shows how this tool can be used to analyze transaction data of a CCP and how policy maker and overseers could obtain information by using this tool.

16. Adding a network dimension to Liquidity Coverage Ratios
Richard Heuver, Ron Berndsen

Using payment data we create an approximation of LCR, which creates the possibility to anticipate liquidity coverage statistics at daily level. Moreover it enables us to place this statistic in a network perspective opening the possibility to look at secondary round effects and locations in the payment network that are most vulnerable.

17. Regulation, supranational bank supervision, and the corporate structure of foreign affiliates
Natalya Martynova, Razvan Vlahu (started in 2016)

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.

18. The determinants of the lifecycle investment profile of interest rate risk (started in 2016)
Roel Mehlkopf, Servaas van Bilsen (University of Amsterdam), Ilja Boelaars (University of Chicago), Lans Bovenberg (Tilburg University, Netspar)

In this project we explore the determinants of the optimal lifecycle investment strategy for interest rate risk in the context of Defined Contribution pension plans. We explore the sensitivity of optimal investment strategies with respect to model and parameter assumptions. The sensitivity analysis allows us to explore to what extent differences in investment beliefs are able to explain the differences in observed lifecycle strategies across pension providers.

19. The Dutch discount: fact or fiction?
Roel Mehlkopf, Arco van Oord

The asset allocation of European life insurance companies varies substantially across institutions, countries and time. In some countries (e.g. UK, ES) most life insurers are characterized by low balance sheet risk, in the sense that liabilities are covered with assets that have similar risk characteristics. In particular, guaranteed cash flows on the liability side of the balance sheet are (more or less) matched with a fixed income portfolio with a similar duration. In other countries (e.g. DE, SE, AT), in contrast, most life insurers are characterized by substantial mismatches as long-term guarantees on the liability side of the balance sheet are covered by equity investments and/or fixed income products with a shorter duration. We study: (1) the determinants of the asset allocation of life insurers across institutions and countries and; (2) the relationship between asset allocation and shareholder value. We introduce a stylized theoretical model for the optimal asset allocation of a life insurance company in which shareholder value is maximized. First, we show under which conditions balance sheet risk taking does not create shareholder value. Subsequently, we show that balance sheet risk taking becomes optimal if we extend the model with additional factors: (1) financing via debt and limited liability of shareholders; (2) risk-based capital requirements in the Solvency II framework; (3) the presence of implicit or explicit government guarantees, and (4) fiscal distortions. Based on this theoretical framework, we formulate a hypothesis regarding the way in which institution specific and country-specific observables explain the asset allocation across institutions and countries, and how these asset allocations correlate with shareholder value. We test this hypothesis with EIOPA balance sheet data. We apply a regression in which we use as the dependent variable the market value of stocks relative to the (Solvency II) value of own funds, while we predictors are the Solvency II mismatch factors (the SCR components), country dummies, etc. In particular, this allows us to determine which mismatch factors increase shareholder value, and which ones do not.

20. Counterparty credit risk in the European CDS market
Sînziana Petrescu, Iman van Lelyveld

Counterparty Credit Risk (CCR) has become a high profile risk faced by banks active in the financial markets. When Lehman Brothers defaulted on its debt and swap obligations in 2008, systemic risk concerns increased the credit spread of large dealer banks up to extreme values, pushing them as high as 500 basis points. The value of protection bought via derivatives dropped significantly causing balance-sheet losses to their buyers. Despite all this, scant empirical research has been done on how CCR is actually priced. This is mostly because of a lack of available data at transaction level. The newly available derivatives data set gathered by trade repositories since 2014 allow for such analysis. We will analyze a cross section of dealers active in the European market and see to what extent prices of index CDSs sold are influenced by the credit risk of their seller. We can directly test whether counterparty credit risk is priced using a panel regression of the price of the index CDS sold on the price of protection of the dealer itself at the end of the previous day. We will use novel data gathered by DTCC (a trade repository) together with public sources of data like SNL and Bloomberg to build the data set.

21. Identifying cyclical patterns in risk indicators based on financial market infrastructure data.
Monique Timmermans, Ronald Heijmans, Hennie Daniels (Tilburg University)

This paper studies cyclical patterns in risk indicators based on TARGET2 data. These indicators may need correction for seasonal/periodical patterns. This paper investigates what the best way is to investigate these patterns. We look at ARIMA models with dummies and at the TBATS model. Besides looking at the cyclical patterns we also investigate which model is best to be used for forecasting. As risk indicators can be used for monitoring by central banks (e.g. monthly) we need to know when a development in a risk indicators deviates significantly enough to cause an alarm.

22. Detection of anomalies in liquidity flows in real time gross settlement systems
Ron Triepels (Tilburg University), Ronald Heijmans, Henie Daniels (Tilburg University)

This paper investigates how an auto encoder with lossy data compression can detect anomalous liquidity flows in a large value payment system (LVPS). We evaluate the performance of two auto encoder types on historical LVPS data and take a closer look at anomalies put forward by the networks. Finally, we perform a series of simulations to determine how the auto encoders respond to different types of artificially generated bank-runs. Our results show that artificially generated bank runs are easily picked up by our method. Furthermore, the number of identified outliers is relatively low in historical data.

23. Life-cycle investment strategies in IDC pension schemes
Annick van Ool, Dirk Broeders, Rob Bauer (University of Maastricht)

During the last few years defined contribution (DC) pension schemes have become increasingly popular in the Netherlands. In order to prevent large changes in the expected pension benefit level just before retirement, participants should take less investment risk by applying a decreasing equity exposure over time towards retirement captured in a so called life-cycle investment strategy. For the determination of the optimal portfolio allocation, not only the optimal equity exposure, but also the optimal exposure to interest rate risk has to be determined. A key assumption for deriving an optimal portfolio allocation is the relation between the equity risk premium and the interest rate. Different views are possible. One can assume that the return on stocks, consisting of the interest rate and the equity premium, is independent of the interest rate (i.e. constant over time). An alternative view is the assumption of a constant equity premium which implies that the return on stocks is dependent on the interest rate. We will investigate the impact of these assumptions on the asset and interest rate risk allocation and look at the performance of the portfolio allocations in case the assumption regarding the equity premium turns out to be wrong ex-post. Finally, we will investigate the impact of the assumption of non-negative interest rates on the optimal portfolio allocation. In this way we also try to evaluate model sensitivity. We will use the Black-Scholes-Vasicek model to determine the optimal portfolio allocation. This model includes interest rate risk and allows for negative interest rates. Moreover, the Cox-Ingersoll-Ross model will be explored which avoids the possibility of negative interest rates. We will compare the optimal portfolio allocation in both models. Since we are interested in the investment strategy in IDC pension schemes, short positions are not allowed and pension contributions are predetermined.

24. Entropy-based implied volatilities and its information content
Xiao Xiao (Erasmus University Rotterdam), Chen Zhou

We investigate the maximum entropy method for estimating the implied volatility, which contributes to understanding the perception of uncertainty in the financial market. Compared to existing methods the maximum entropy method has the main advantage that it is free of model uncertainty. We expect that the maximum entropy method will outperform the existing methods in extracting implied volatility such as the Black-Scholes implied volatility and the model-free implied volatility. We will further examine the information content of the entropy-based implied volatility. We expect that it will perform better in forecasting future realized volatility and the entropy-based variance risk premium performs better in predicting future market returns.

4. Financial literacy and behavior of households and companies

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

Ecommerce 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 and what preferences do they have? What does it mean for market structure, competition and its effect on pricing? How do network effects come into play? Using recent Dutch survey results 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 cost, price levels and inflation.

2. Consumption effects of positive and negative transitory shocks to income
Dimitris Christelis (CSEF), Dimitris Georgarakos (Bundesbank), Tullio Jappelli (University of Naples), Maarten van Rooij

Using a survey among a representative sample of Dutch households, we examine to what extent respondents would consume an unexpected, transitory and positive income change. In addition, we examine whether an unexpected, transitory and negative income change would reduce the consumption of respondents.

3. Mode effects on self-reported household financial data (started in 2015)
Wändi Bruine de Bruin (Leeds University Business School), Wilbert van der Klauw (Federal Reserve Bank of New York), Maarten van Rooij, Federica Teppa, Klaas de Vos (CentERdata)

We conduct an experiment in which participants are randomly assigned to survey modes to examine the effect of internet survey vs. face-to-face interview mode on reported financial information. We aim to measure the accuracy of responses to asset, debt, income and expense questions and the variation across different modes. We investigate the effect of the interview mode on the willingness of individuals to report financial information and on the accuracy of their answers. For the latter, we use objective financial records that respondents have sent in to the survey agency after having participated in the survey.

4. To stay or leave? Consumer bank switching behaviour after government interventions (started in 2016)
Maaike Diepstraten (Tilburg University), Carin van der Cruijsen

We analyze how consumers respond to government interventions at banks. On the one hand, the default risk-reducing hypothesis predicts that customers of bailed out banks are more inclined to stay at their bank than customers of other banks. On the other hand, there might be reasons why consumers do want to switch away from the intervened bank (e.g. lack of trust in the government). Our study complements previous studies on consumer responses to government interventions by employing a difference-in-difference analysis, separating between a nationalization and capital injection and directly testing the channels.

5. Retailers only accepting cash or cards
Nicole Engel, Nicole Jonker, Esther vd Kommer

Most retailers accept both cash and card payments. However, some either only accept cash payments or only debit card payments. In this study we will examine to what extent merchants only accept one means of payment and-which factors drive their decisions to stop accepting cash or to not accepting card payments. In addition, we will examine to what extent this can be modulated in a 'what if' scenario in order to see the sensitivity of the retailers' decisions to stop the acceptance of a means of payment. We will first interview a small group of merchants that only accept card payments and in the second stage we will carry out a survey among a large sample of merchants.

6. Intraday payment choices: mainstream vs. payments innovations (started in 2014)
Lola Hernandez, Nicole Jonker

Payment instruments play a key role in channeling consumers' money into the economic pipeline. Increasing the efficiency of the payment system is then a crucial task of central banks. To better understand what determines the role of payment instruments, it is fundamental to study what determines their use at different moments. This paper aims at better understanding this by shedding light on consumers' cash management as well as their use of new forms of payments as contactless cards. This study uses detailed transaction information using cash, debit cards and new forms of payments as well as cash withdrawals. The focus of this paper will be on cash management and tracking people's payments, using detailed information on their cash balances and transaction characteristics, such as their order and size. In order to do this, it will use shopping diary data collected in an extensive payment survey in 2013 among more than 8,000 Dutch consumers.

7. Acceptance means of payments by e-retailers
Nicole Jonker, Monique Timmermans

We aim to gain insight into which factors influence the adoption, acceptance and usage of means of payment by businesses, and to examine to what extent large enterprises, small and medium sized enterprises differ from each other in this respect. We pay special attention to the acceptance of virtual currencies. Questions addressed include: Which means of payment do e-retailers accept from consumers? How do e-retailers perceive the safety, internal costs, external cost (including bank fees), user friendliness, transaction speed of different means of payment intended for accepting C2B payments? Which factors influence the adoption and usage of virtual currencies as a means of payments and which factors act as barriers?

8. Financial literacy and pension expectations (started in 2016)
Remko Struik, Maarten van Rooij, Rob Alessie (University of Groningen)

We have conducted a survey among employees in het CentERpanel on their level of financial literacy, expected retirement age and replacement rate in 2015. In this paper, we compare these expectations with the outcomes of a similar 2010 survey. Moreover, we analyze whether the updating of pension expectations is related to financial literacy or other personal characteristics.

9. The role of information on the formation and revision of subjective survival expectations (started in 2016)
Federica Teppa, Susan Thorp (University of Sidney), Hazel Bateman (UNSW)

The divergence between subjective and objective survival expectations can lead to retirement planning problems and public policy challenges. We test the effect on subjective survival expectations of supplying cohort and/or ancestor survival information to 4000 experimental subjects from two countries. We then evaluate their attitudes to pension age increases and personal savings. Personalized longevity information generally does not induce the expected revisions to subjective expectations. ``Live to" and ``die by" framing has a much larger effect on reported subjective expectations. Yet subjective expectations are relevant to explaining opinions on pension policy and savings.

10. Payment data and consumers' privacy (started in 2016)
Carin van der Cruijsen

The National Forum on the Payment System has commissioned a survey about consumers' attitudes towards the use of payment data by banks. The independent research agency Motivaction surveyed Dutch citizens. The main finding is that whereas the use of payment data is well accepted in several instances, for example, to enhance security or improve services, most people don't accept its use for commercial purposes. The goal of this research project is to deepen insights. The first step is to use the outcomes of nine scenarios to construct an overall measure of consumers' attitude towards payment data use. Next, differences in attitudes will be related to personal characteristics and other variables.

11. Regional payment patterns and social norms
Carin van der Cruijsen, Joris Knoben (Radboud University)

Previous studies have shown that there are regional differences in consumers' payment behaviour, that the strength of regional patterns varies per point-of-sale, and that regional patterns can change over time. This research gives more insight in regional payment patterns and the effect of social norms on payment behaviour. Many researchers have shown that payment behaviour is related to personal characteristics. We research to what extent payment behaviour is also related to characteristics of the environment. Thereby, we test the relevance of social norms. Our analysis will be based on payment diary data that includes information on where people live. We combine this with other regional data.

12. Using point-of-sale payment data for estimating household consumption (started in 2015)
Roy Verbaan, Wilko Bolt, Carin van der Cruijsen

Collecting statistical information on consumers' expenditures is expensive and time-consuming. As an alternative, in this study we will examine the usefulness of retail payments data for estimating household consumption patterns and identifying leading indicators for business cycles. Usage of payment data sources seem to be very promising: they provide detailed information with respect to the timing of consumption and the nature of consumption and in case of diary data consumption can be linked to demographic characteristics of respondents. We will use two payment data sources. The first data source that we use is payment diary information. Consumers report detailed information on all individual payments made during the day at all points-of-sale in the Netherlands. DNB and the Dutch Payments Association collect these data from September 2013 onwards among the members of the GfK consumer panel. This dataset includes information on domestic demand for expenditures in 14 different POS sectors. These data may provide preliminary estimates of household consumption on daily needs. The second data source is monthly information on the number and value of debit card payments, distinguishing between 21 sectors and available from January 1995 onwards. We study whether potential leading indicators to forecast swings in overall consumption can be identified.

13. Economic and institutional determinants of mortgage default (started in 2015)
Razvan Vlahu, Irina Stanga (University of Groningen), Jakob de Haan

This paper studies the potential causes of cross-country variation in mortgage defaults. We examine whether in addition to the macroeconomic risks and mortgage market characteristics, the peculiar features of countries' institutional and legal environment matter.

5. Modelling and forecasting

1. Forecasting with large panel data sets (started in 2015)
Andreas Pick

This research project investigates methods for forecasting with large panel data sets. An application is that of Bernoth and Pick (2011, JBF), who investigate forecasts of banking and insurance vulnerabilities. The current project aims to further the understanding of forecasting in such data sets, to develop new forecasts, and compare those forecasts to existing forecasting methods.

2. Economic sentiment and the influx of refugees
Ad Stokman, Maikel Volkerink

More than a million migrants and refugees crossed into Europe in 2015, sparking a crisis as countries struggled to cope with the influx. From an economic perspective most research focuses on labor market and fiscal effects of asylum migration. This research project addresses a new channel: the impact on economic sentiment. For the Netherlands we find that peaks in asylum migration have a negative effect on economic sentiment. Next to methodological advancements, we want to address new questions; does the negative effect mostly reflect fears of economic hardship or feelings of job insecurity? Does the effect differ among groups in society? Is the effect present in other European countries as well?

6. Other

1. Sustainable debit card payment system
Erik Roos Lindgreen, Milan van Schendel, Marc Davidson, Nicole Jonker, Jorieke Kloek

In this study we will examine the environmental impact of the debit card payment system, while maintaining the current level of safety, reliability and efficiency.

2. Sustainable cash payment system
Atakan Larcin, Randall Hanegraaf, Nicole Jonker, Jelle Miedema

In this study we will examine the environmental impact of the cash payment system, while maintaining the current level of safety, reliability and efficiency.