Research News 2015

Research Division at Sveriges Riksbank

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This newsletter describes the research activities and output of the Research Division at Sveriges Riksbank in 2015.

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Per Krusell, visiting scholar
Mats Levander, PhD student at SSE
Jesper Lindé, head of research
Lena Löfgren, secretary
Conny Olovsson, research economist
Matias Quiroz, post-doctoral fellow
Jessica Radeschnig, research assistant
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David Vestin, research economist
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Leo Voltaire, research assistant
Erik von Schedvin, research economist
Karl Walentin, research economist
Andreas Westermark, research economist
Xin Zhang, research economist

Reflections by the head of research

2015 is an exceptional year in Riksbank history. For the first time in its almost 350-year history, the Riksbank cut its main policy rate below zero. According to the newest monetary policy report, it is expected to remain negative well into 2017: the record-low policy rate is needed for inflation to rise towards the target in an international environment with extremely low interest rates. At the same time, Swedish housing prices have risen significantly in an international perspective, begging the question of a possible overvaluation in the market at least in some regions. Amid the need to maintain low policy rates to ensure price stability, the developments in the housing market have spurred discussions about which macro-prudential tools can be used to prevent a buildup of financial imbalances (which may lead to bad macroeconomic outcomes down the road).

During the year that has passed, the Research Division has made important contributions to these issues by arranging workshops on the causes and consequences of deflation, and the interplay between price- and financial stability in the conduct of monetary policy. Division staff has also done research on the effects on unconventional tools in monetary policy as well as the effects of macro-prudential tools; specifically the consequences for household indebtness of adopting an amortization requirement.

To deepen our understanding of the nexus between price-, fiscal- and financial stability, the Riksbank has also joined the Trinity research network. One of the initiators of the Trinity network is our scientific adviser Eric M. Leeper, and the news features an exclusive interview with Eric about his thoughts on the network and some other interesting issues as well (see below). Even so, the Research Division staff have of course worked on a wide range of topics, and in case you, Dear Reader, is able to take some time and look through our Research News, I am sure you will impressed by the depth and breadth of our work. This year, our featured article is Tor Jacobson's and Erik von Schedvin's paper on trade credits, which was just published in *Econometrica*.

With this, I am over and out. I wish You a good read of our news, happy holidays and a productive and successful 2016!

Jesper Lindé

Interview with Eric M. Leeper

Rudy Professor of Economics at Indiana University and scientific advisor to the Riksbank

1. *Eric, you have been an academic advisor to the Riksbank since 2002 – what has led you to serve in such capacity for such a long time?*

Inertia. Actually I stick with it because the job has made me a better economist. As an academic, it is easy to get far removed from practical policy matters. And the farther removed one is, the less relevant the research is likely to become (in my opinion). Advising the Riksbank forces me to try to link academic research to real-world questions.

Changes in the research staff

Several changes occurred within the research staff in 2015. **Ferre De Graeve** left his position of senior economist at the research division to become an associate professor in the Faculty of Economics and Business at KU Leuven. **David Vestin** joined our division as a senior advisor, after having worked as deputy director of the monetary policy department for the Riksbank. Prior to that, David worked at the Bank for International Settlements in 2008 and the European Central Bank from 2001 to 2008. **Marieke Bos** left her position of visiting researcher in our division to join the Swedish House of Finance as a visiting scholar. **Leo Voltaire** and **Vicke Norén** both left their positions as research assistants in the fall to start new jobs at IF Insurance Company and the Swedish Financial Supervisory Authority respectively. The research division therefore hired two new research assistants: **Emilio Dermani** and **Jessica Radeschnig**. Emilio received his BS in Statistics and Actuarial Financial Mathematics at the University of the Aegean in Greece, and an MS in Financial Mathematics and Finance at Stockholm University. Jessica received her BS in Applied Mathematics and in Economics from Mälardalen University and is close to receiving a MS in Applied Mathematics from the same institution. **Jesper Böjeryd** also joined the division as a research assistant for Marieke Bos and Peter van Santen. Jesper received a BS and two MS, one in Applied Mathematics and Computational Mathematics and one in Civil Engineering, all from the Royal Institute of Technology.

Summary of featured article

The following is a summary of the article by Tor Jacobson and Erik von Schedvin titled "Trade Credit and the Propagation of Corporate Failure: An Empirical Analysis," which was published in Econometrica, Vol. 83, pp. 1315-1371.

Theory predicts that trade credit chains make up a channel through which liquidity shocks are propagated in the economy: Nobuhiro Kiyotaki and John Moore provide the seminal contribution. A trade credit debtor (customer) in bankruptcy will almost surely default on the claims held by its trade creditors (suppliers), and thereby invoke credit losses. Such credit losses could, in turn, push the trade creditors into insolvency and subsequent bankruptcy. Thus, trade credit chains are potentially an important mechanism through which corporate failures are propagated in the economy. Moreover, the trade credit failure propagation mechanism may also play a wider role by amplifying the impact of idiosyncratic shocks towards persistent effects on aggregate output. Along these lines, recent research proposes that the propagation of idiosyncratic shocks through inter-firm linkages have macroeconomic relevance—in contrast with conventional wisdom dictating that shocks at the firm-, or sector-level, will cancel out in the aggregate, i.e., the diversification argument. However, although trade credit chains are likely to propagate corporate failure and generate aggregate effects, there is so far no empirical work that directly examines the trade credit failure propagation mechanism, most likely due to data limitations on trade credit chains.

Our contribution is empirical and explores the importance of trade credit chains for the propagation of corporate failures. To this end, we have compiled a vast Swedish data set containing information on all corporate bankruptcies and associated trade credit claims. The richness of the data provides an opportunity to quantify the risks associated with trade credit issuance and failure, conditional on precise creditor and debtor characteristics. We begin by relating creditor issuance of trade credit to the credit losses incurred in trade debtor failures, and thereby establish and quantify the credit risks involved in trade credit. We then move on to a comprehensive characterization of the bankruptcy risk that trade debtor failures impose on trade creditors—with a focus on credit loss effects for creditor failure risk. The latter provides direct inference on the propagation mechanism in trade credit chains for corporate failure contagion.

The empirical analysis yields four key findings. Firstly, our firm-level results show that trade credit issuance is associated with quantitatively important credit losses. Secondly, we document that trade debtor failures are associated with a substantially enhanced bankruptcy risks for the trade creditors; moreover, these risks are elevated in the size of the trade credit losses. Our results persist in specifications controlling for confounding effects from common shocks, endogenous matching, and reverse causation; suggesting a causal propagation mechanism such that debtor failures lead to creditor failures. Thirdly, we evaluate the relative importance of the credit and demand loss channels in models where we condition the estimated effects of trade credit losses and of debtor-specific demand losses on measures of financial constraints and the strength of supplier-customer ties. Our results suggest that both channels are important for the documented propagation mechanism. Last, we demonstrate that the propagation mechanism constitutes a significant parts of the aggregate bankruptcy frequency, thus supporting the notion that trade credit chains may function as an amplifier of idiosyncratic shocks to the aggregate level.

These results build on trade credit being an important source of short-term financing for Swedish firms in combination with an institutional setting where trade creditors have a junior priority status in bankruptcy proceedings. Such conditions prevail across countries and legal systems, which suggests that our results are general in nature and extend beyond the firms explored in this analysis.

Research projects pursued in 2015

ASSET PRICING

Measuring Systemic Downside Risk Component of Asset Prices
Roméo Tédongap and Xin Zhang

We develop a representative agent consumption-based general equilibrium asset pricing model featuring generalized disappointment aversion preferences and multi-frequency long-run volatility risk, and which allows for closed-form bond prices, stock prices, credit derivatives and inflation derivatives. We estimate the model parameters and state dynamics to match moments of the daily stock index return and yield curve, and the default parameters by fitting moments of the daily term-structure of credit default swap spreads. We analytically decompose asset prices into two major components: a regular component and a systemic risk component. Our results point to a significant contribution of systemic risk to asset prices that is more important during crisis times.

(continuing from previous year)

Default Exposure to Downside Risks and the Cross-section of Expected Returns
Roméo Tédongap and Xin Zhang

Intertemporal consumption-based equilibrium asset pricing, featuring downside risks through disappointment aversion preferences, implies that investors value assets through their undesirable exposure to two regular (market return and volatility) and three downside risk factors (the disappointment factor, the market downside factor, and the volatility downside factor). We show that these factors have both a predictive and a contemporaneous relationship with credit derivative swap spreads. Our results are robust to including macroeconomic factors, firm characteristics and other tail risk factors in the literature. We measure individual firm credit risk exposure to regular and downside risk factors using the CDS term structure. We find that the exposure information is also incorporated in the cross-section of expected stock returns and CDS spreads.

BARGAINING THEORY

Long-Term Relationship Bargaining
Andreas Westermark

We analyze a bargaining model where there is a long-term relationship between a seller and a buyer and there is bargaining over a sequence of surpluses that arrives at fixed points in time. Markov Perfect Equilibria are analyzed and equilibrium payoffs characterized. The transfers between the players can be described as a first-order system of difference equations. Payoffs depend on both current and future surpluses. Future surpluses are important partly because the risk of separation leads to the loss of surplus today and in the future and partly because delay without separation can last into future periods. We also find conditions for existence and uniqueness of equilibria with immediate agreement.

(continuing from previous year)

COMPUTATIONAL ECONOMICS

Approximate Dynamic Programming with Post-Decision States as a Solution Method for Dynamic Economic Models
Isaiah Hull

I introduce and evaluate a new stochastic simulation method for dynamic economic models. It is based on recent work in the operations research and engineering literatures (Van Roy et. al, 1997; Powell, 2007; Bertsekas, 2011), but also had an early application in economics (Wright and Williams, 1982, 1984). The baseline method involves rewriting the household's dynamic program in terms of post-decision states. This makes it possible to choose controls optimally without computing an expectation. I add a subroutine to the original algorithm that updates the values of states not visited frequently on the simulation path; and adopt

a stochastic step size that efficiently weights information. Finally, I modify the algorithm to exploit GPU computing.

(accepted for publication)

CREDIT AND BANKING

Trade Credit and the Propagation of Corporate Failure: an Empirical Analysis
Tor Jacobson and Erik von Schedvin

Using an exhaustive data set on claims held by trade creditors (suppliers) on failed trade debtors (customers), we quantify the importance of trade credit chains for the propagation of corporate bankruptcy. We show that trade creditors experience significant trade credit losses due to trade debtor failures and that the creditors' bankruptcy risks increase in the size of incurred losses. By exploring the role of financial constraints and creditor-debtor dependence, we conclude that the propagation mechanism is driven by both credit losses and demand shrinkage. Furthermore, propagation is mitigated for less-leveraged, cash rich, and profitable creditors. It is instead enhanced during economic downturns.

(accepted for publication)

On the Non-Exclusivity of Loan Contracts: An Empirical Investigation
Hans Degryse, Vasso Ioannidou and Erik von Schedvin

A string of theoretical papers shows that the non-exclusivity of credit contracts generates important negative contractual externalities. Employing a unique dataset, we identify how these externalities affect the supply of credit. Using internal information on a creditor's willingness to lend, we find that a creditor reduces its credit supply when a borrower obtains a loan at another creditor (an "outside loan"). Consistent with the theoretical literature, the effect is more pronounced the larger the outside loans. It is instead muted if the initial creditor's existing and future loans retain seniority over the outside loans and are secured with valuable collateral.

(accepted for publication)

Curbing Shocks to Corporate Liquidity: The Role of Trade Credit
Niklas Amberg, Tor Jacobson, Robert Townsend and Erik von Schedvin

This paper quantifies firms' use of trade credit to handle shortfalls in liquidity. We find that firms manage declines in cash flow by increasing the amount of drawn trade credit from suppliers and contracting the amount issued to customers. The compounded adjustments in the amount of drawn and issued trade credit dominate adjustments in cash holdings, which suggest that trade credit positions are economically important sources of reserve liquidity. We tackle fundamental endogeneity concerns arising when relating cash flow to trade credit utilization by studying how losses from a fraudulent scheme initiated by a cash-in-transit firm affected its customers.

(continuing from previous year)

Effect of Corporate Liquidity on Swedish Exports during the 2008-2009 Financial Crisis
Laurent Bach, Tor Jacobson and Erik von Schedvin

We have been able to purchase firm-level export data from SCB and match it with data from UC on corporate defaults and balance sheet information. This has allowed us to check that Swedish exporting firms have been particularly hit during the period going from October 2008 to June 2009. Interestingly, the degree of export reduction during that period is closely rated to the amount of cash holdings held by firms prior to the crisis. We make the hypothesis that this is because keeping a long-term export activity requires a large amount of working capital, but outside funding for working capital was unavailable during the crisis. What further confirms this hypothesis is that cash holdings were particularly useful around 2008-2009 in preserving export relationships with faraway destinations, for which working capital requirements are the biggest. Since we were given access to client data from the Swedish loan guarantee agency, we are now investigating whether export loan guarantees provided by the government were able to substitute for cash holdings and help cash-poor firms sustain their export activity during the financial crisis.

(continuing from previous year)

Inter-Firm Lending: An Empirical Analysis of Trade Credit Contracts
Tore Ellingsen, Tor Jacobson and Erik von Schedvin

We study around 52 million trade credit contracts, issued by 50 suppliers over 9 years to 199.000 customers. The data contain information on contract size, due dates, time to payment, and firm characteristics. This data allows us to explore how changing conditions affect contract terms at the level of suppliers-customers pairs. We find that opportunity cost of funds, market power, and information asymmetries impact on the contract terms, where the former dominates, especially for the transacted volume. Financial frictions have little impact on agreed contract duration, but firms with higher liquidity needs draw more credit from suppliers by postponing payments.

(continuing from previous year)

Evaluating the Loan-to-Value Cap in Sweden
Tor Jacobson, Mats Levander and Kasper Roszbach

In October 2010 the regulatory supervisor in Sweden issued a recommendation to banks to cap their mortgage lending at 85%. Using a recent micro dataset on mortgage loans from a large Swedish retail bank we try to discern the effects of the cap for changes in borrowers' behavior. The richness of the data allows us to control for a wide range of important aspects such as households' uncollateralized borrowing from the incumbent bank, as well as their borrowing in general from other banks.

The Importance of Reallocation for Productivity Growth: Evidence from European and U.S. Banking
Jaap Bos, and Peter van Santen

To what extent has input reallocation contributed to aggregate productivity growth in the banking sectors of Europe and the United States? Interestingly, under-performing banks capture market share, while more productive banks lose market share, in particular in the US. The pattern of reallocation is markedly different between the geographical regions: European productivity has grown by reallocating inputs through the first half of the sample period, at the same time when reallocation diminished growth in the US. The long-run positive effects of creative destruction are especially apparent in the US, where reallocation is an important driver of increases in productivity.

(continuing from previous year)

Economic Distress and Consumers' Credit Choice
Marieke Bos, Chloé le Coq and Peter van Santen

Mullainathan, Shah and Shafir argue that scarcity, defined as "having less than you feel you need" impedes cognitive functioning, which in turn may lead to decision-making errors and myopic behavior. We study if the level of economic recourses influences the borrowers' decision making by exploiting within borrower variation in the number of days between consecutive paydays. In Sweden, salaries are typically paid on the 25th of each month. However no transfers are made on weekend- and national holidays, which cause the number of days between paydays in Sweden to vary significantly between months and years. We use this exogenous variation in the level of economic recourses before payday to empirically investigate if credit choice is influenced by economic circumstances. For this purpose we utilize a panel of low income households' that includes their repeated credit contract choice and repayment behavior in both the mainstream- and alternative credit market.

ECONOMETRICS

Dynamic Mixtures-of-Experts Models for Longitudinal and Discrete-Time Survival Data
Matias Quiroz and Mattias Villani

We propose a general class of flexible models for longitudinal data with special emphasis on discrete-time survival data. The model is a finite mixture model where the subjects are allowed to move between components through time. The time-varying probability of component memberships is modeled as a function of subject-specific time-varying covariates. This allows for interesting within-subject dynamics and manageable computations even with a large number of subjects. Each parameter in the component densities and in the mixing function is connected to its own set of covariates through a link function. The models are estimated using a Bayesian approach via a highly efficient Markov Chain Monte Carlo (MCMC) algorithm with tailored proposals and variable selection in all set of covariates. The focus of the paper is on models for discrete-time survival data with an application to bankruptcy prediction for Swedish firms, using

both exponential and Weibull mixture components. The dynamic mixture-of-experts models are shown to have an interesting interpretation and to dramatically improve the out-of-sample predictive density forecasts compared to models with time-invariant mixture probabilities.

(continuing from previous year)

Speeding up MCMC by Efficient Data Subsampling
Matias Quiroz, Mattias Villani and Robert Kohn

The computing time for Markov Chain Monte Carlo (MCMC) algorithms can be prohibitively large for datasets with many observations, especially when the data density for each observation is costly to evaluate. We propose a framework where the likelihood function is estimated from a random subset of the data, resulting in substantially fewer density evaluations. The data subsets are selected using an efficient Probability Proportional-to-Size (PPS) sampling scheme, where the inclusion probability of an observation is proportional to an approximation of its contribution to the log-likelihood function. Three broad classes of approximations are presented. The proposed algorithm is shown to sample from a distribution that is within $O(m^{-1/2})$ of the true posterior, where m is the subsample size. Moreover, the constant in the $O(m^{-1/2})$ error bound of the likelihood is shown to be small and the approximation error is demonstrated to be negligible even for a small m in our applications. We propose a simple way to adaptively choose the sample size m during the MCMC to optimize sampling efficiency for a fixed computational budget. The method is applied to a bivariate probit model on a data set with half a million observations, and on a Weibull regression model with random effects for discrete-time survival data.

(continuing from previous year)

Scalable MCMC for Large Data Problems using Data Subsampling and the Difference Estimator
Matias Quiroz, Mattias Villani and Robert Kohn

We propose a generic Markov Chain Monte Carlo (MCMC) algorithm to speed up computations for datasets with many observations. A key feature of our approach is the use of the highly efficient difference estimator from the survey sampling literature to estimate the log-likelihood accurately using only a small fraction of the data. Our algorithm improves on the O(n) complexity of regular MCMC by operating over local data clusters instead of the full sample when computing the likelihood. The likelihood estimate is used in a Pseudo-marginal framework to sample from a perturbed posterior which is within $O(m^{-1/2})$ of the true posterior, where m is the subsample size. The method is applied to a logistic regression model to predict firm bankruptcy for a large data set. We document a significant speed up in comparison to the standard MCMC on the full dataset.

Speeding Up MCMC by Delayed Acceptance and Data Subsampling
Matias Quiroz

The complexity of Markov Chain Monte Carlo (MCMC) algorithms arises from the requirement of a likelihood evaluation for the full data set in each iteration. Payne and Mallick (2014) propose to speed up the Metropolis-Hastings algorithm by a delayed acceptance approach where the acceptance decision proceeds in two stages. In the first stage, an estimate of the likelihood based on a random subsample determines if it is likely that the draw will be accepted and, if so, the second stage uses the full data likelihood to decide upon final acceptance. Evaluating the full data likelihood is thus avoided for draws that are unlikely to be accepted. We propose a more precise likelihood estimator which incorporates auxiliary information about the full data likelihood while only operating on a sparse set of the data. It is proved that the resulting delayed acceptance MCMC is asymptotically more efficient compared to that of Payne and Mallick (2014). Furthermore, we adapt the method to handle data sets that are too large to fit in Random-Access Memory (RAM). This adaptation results in an algorithm that samples from an approximate posterior with well-studied theoretical properties in the literature.

Modeling Financial Sector Joint Tail Risk in the Euro Area
André Lucas, Bernd Schwaab and Xin Zhang

We develop a novel high-dimensional non-Gaussian modeling framework to infer measures of conditional and joint default risk for numerous financial sector firms. The model is based on a dynamic Generalized Hyperbolic Skewed-t block-equicorrelation copula with time-varying volatility and dependence parameters that naturally accommodates asymmetries, heavy tails, as well as non-linear and time-varying default dependence. We apply a conditional law of large numbers in this setting to define joint and conditional risk measures that can be evaluated quickly and reliably. We apply the modeling framework to assess the joint

risk from multiple defaults in the euro area during the 2008--2012 financial and sovereign debt crisis. We document unprecedented tail risks between 2011--2012, as well as their steep decline following subsequent policy actions.

(accepted for publication)

Generalized Autoregressive Score Model with Realized Measures of Volatility
Zhuo Huang, Tianyi Wang and Xin Zhang

We propose a new observation-driven dynamic parameter framework to model the financial return and realized variance jointly with a fat-tailed distribution. The latent true volatility is driven by the conditional density score, which is a weighted function of past daily return and realized variance. The new model mitigates the influence of extreme realizations, such that the volatility dynamics is robust to outliers in the observations. In the meanwhile, it adapts quickly to drastic volatility changes by incorporating realized measures of volatility based on high frequency data. Consequently the model provides a good in-sample and out-of-sample fit to both returns and realized variance. We apply the model to a number of stock market indices and demonstrate its promising performance, even during the recent financial crisis periods.

(continuing from previous year)

Score Driven Exponentially Weighted Moving Averages and Value-at-Risk Forecasting
André Lucas and Xin Zhang

A simple methodology is presented for modeling time variation in volatilities and other higher order moments using a recursive updating scheme similar to the familiar RiskMetrics approach. We update parameters using the score of the forecasting distribution. This allows the parameter dynamics to adapt automatically to any non-normal data features and makes the subsequent estimates more robust. The new approach nests several of the earlier extensions to the exponentially weighted moving average (EWMA) scheme. In addition, it can easily be extended to higher dimensions and alternative forecasting distributions. The method is applied to Value-at-Risk forecasting with (skewed) Student's t distributions and a time-varying degrees of freedom and/or skewness parameter. We show that the new method is competitive to or better than earlier methods in forecasting volatility of individual stock returns and exchange rate returns.

(accepted for publication)

Time Varying Tail Risk in the Sovereign Bond Market
Bernd Schwaab and Xin Zhang

This paper studies time-variation of tail risk in the sovereign bond market. The tail risk dynamics is driven by the score of the likelihood, i.e. the tail index parameter is a function of past observations. As far as the likelihood satisfies standard regularity conditions, the model provides an unbiased estimate of the dynamic tail index. Unlike other models for measuring tail risk, our model is consistent with the extreme value theory and can be extended to multivariate setting easily. We show its good performance in capturing the tail risk variation with Monte Carlo simulations. Applying the model to sovereign bond yield data from several Euro Area countries, we show that the Securities Markets Programme (SMP) changes the tail risk dynamics during the European sovereign debt crisis.

Static and Dynamic Binary Response Models with Misclassified Dependent Variables Applied to Annuity Ownership
Rob Alessie, Adriaan Kalwij and Peter van Santen

We study the problem of misclassification of the dependent variable in a binary choice setting. The literature has paid attention to the static (cross-sectional data) case, and finds that misclassification yields biased estimates of the parameters of interest. Much less is known about the dynamic (panel data) case. We derive the likelihood of the observed outcomes in a dynamic panel probit model, and discuss two approaches to parameter estimation. First, as proposed by Keane and Sauer (2009, Econometrica), one may resolve to simulating the entire process generating the data, and use simulated maximum likelihood to estimate the parameters. Second, we can formulate the problem as a hidden Markov model. This setup allows us to use a recursive algorithm to compute the likelihood function without simulations. The expectation-maximization (EM) method can then be invoked for parameter estimation. We apply both static and dynamic models to ownership of annuity policies for a panel of Dutch households. The survey data is likely to be error-ridden, as we document transition probabilities in ownership at the household level which seem too large. Moreover, for a subset of households, we know the duration of the policies, and therefore can construct an ownership variable which should be closer to the true value. We use this measure to

benchmark our results. Our estimates of the misclassification probabilities suggest that part of the "annuity puzzle" can be explained by underreporting ownership of annuities.

(continuing from previous year)

FINANCIAL THEORY

Financial Frictions, Investment and Tobin's q
Dan Cao, Guido Lorenzoni and Karl Walentin

We develop a model of investment with financial constraints and use it to investigate the relation between investment and Tobin's q. A firm is financed partly by insiders, who control its assets, and partly by outside investors. When their wealth is scarce, insiders earn a rate of return higher than the market rate of return, i.e., they receive a quasi-rent on invested capital. This rent is priced into the value of the firm, so Tobin's q is driven by two forces: changes in the value of invested capital, and changes in the value of the insiders' future rents per unit of capital. This weakens the correlation between q and investment, relative to the frictionless benchmark. We present a calibrated version of the model, which, due to this effect, generates a realistic joint behavior of investment, q, and cash flow. In particular, the model roughly replicates the values of the coefficients in empirical investment regressions.

(continuing from previous year)

A Detrimental Feedback Loop: Deleveraging and Adverse Selection
Christoph Bertsch

Market distress can lead to a deleveraging wave, as in the 2007/08 financial crisis. This paper demonstrates how market distress and deleveraging can fuel each other in the presence of adverse selection in opaque asset markets. A detrimental feedback loop emerges: investors reduce their reliance on opaque markets by decreasing their leverage which in turn amplifies adverse selection. In the extreme, trade breaks down. Asymmetric information together with incomplete markets is at the root of two inefficiencies: investors' leverage choices are distorted and investors' liquidity management exhibits under-investment in cash. I discuss policy implications and the ambiguous role of transparency.

(continuing from previous year)

A Wake-up Call Theory of Contagion
Toni Ahnert and Christoph Bertsch

Empirical evidence in several fields has identified wake-up calls as an important channel of contagion. We propose a theory of contagion based on the information choice of investors after a wake-up call. We study global coordination games of regime change with two regions where local fundamentals have an unobserved common component. A crisis in the first region is a wake-up call to investors in the second region. This wake-up call induces investors to re-assess the local fundamental and to acquire information about the common component. We show that (i) information acquisition occurs only after a wake-up call; and (ii) contagion occurs even if investors learn that the second region has no exposure to the first region. These results do not rely on common investors or balance sheet links across regions. Our theory of contagion applies to currency crises, runs on financial intermediaries, and sovereign debt crises. A policymaker with favorable news about the local fundamental can mitigate contagion by enhancing transparency.

(continuing from previous year)

Fire Sale Bank Recapitalization
Christoph Bertsch and Mike Mariathasan

We develop a general equilibrium model of banks' capital structure, featuring heterogeneous portfolio risk and an imperfectly elastic supply of bank equity stemming from financial market segmentation. In our model, equity is costly and serves as a buffer against costly bankruptcy. Banks are ex-ante identical, but may need to recapitalize by selling equity claims after their portfolio risk becomes public knowledge. When the need to issue outside equity arises simultaneously in a large number of banks, the market for equity becomes crowded. Reminiscent of asset fire sales, banks do not fully internalize the effect of their individual equity issuance on the endogenous cost of equity and their future ability to recapitalize. As a result, they are under- capitalized in equilibrium, and the incidence of insolvency is inefficiently high. This constrained inefficiency provides a new rationale for macroprudential capital regulation that arises despite the absence of deposit insurance and moral hazard; it also has implications for the regulation of payout policies and the design of bank stress testing.

The Development and Spread of Financial Innovations
Isaiah Hull

I study the process of financial innovation in a model with two classes of agents: ``sophisticated" and ``unsophisticated." Unsophisticated agents are hit with frictions that lower the return to a conventional asset they hold. Sophisticated agents construct financial innovations that are perfect substitutes for the conventional asset, but are not subject to the friction. In the absence of complete information, unsophisticated agents learn about innovations through a contagion process, as they encounter competitors who have already adopted them. The model yields two equilibria. In one, the innovation persists. In the other, it disappears. Only one equilibrium is stable, and this is determined by the strength of the contagion and by early strategic interactions between sophisticated agents. The model suggests mechanisms for several empirical regularities in the financial innovation literature. Additionally, two applications demonstrate how to estimate the contagion parameter with a short time series of volume data, and how to use it to predict whether a financial innovation will spread.

(accepted for publication)

A Model of Costly Intermediation
Paola Boel and Gabriele Camera

We construct a microfounded model of money where banks reallocate idle cash by taking deposits and making loans. Banks are characterized by a labor-intensive technology that induces a real cost for financial intermediaries and therefore a spread between deposit and borrowing rates. Such spread responds to both monetary policy and the efficiency of financial intermediaries. We investigate how labor costs in the banking sector affect equilibrium interest rates, market prices and the welfare cost of inflation.

INTERACTION OF FISCAL AND MONETARY POLICY

Fiscal Multipliers in a Nonlinear World
Jesper Lindé and Mathias Trabandt

Previous work has shown that, in a liquidity trap, aggressive government spending cuts can be self-defeating in the short-run due to a higher-than-normal multiplier. A potentially serious drawback of the existing literature is the use of linearized models. Recently, Braun, Koerber and Waki (2012) and others claim that in a liquidity trap, a model can behave qualitatively different depending on whether it has been linearized or not. We examine their claim with a focus on whether fiscal austerity can be self-defeating - i.e. austerity causes government debt to rise due to adverse effects on aggregate demand. Specifically, we compare the government debt and output effects due to changes in fiscal spending in linearized and nonlinear general equilibrium models. We start with a variant of the simple benchmark model in Woodford (2003), which allows us to carefully parse out the differences between the linear and nonlinear solutions. Finally, we examine the robustness of our results in the workhorse model of Christiano, Eichenbaum and Evans (2005) augmented with a financial accelerator mechanism.

(continuing from previous year)

Fiscal Consolidations under Imperfect Credibility
Matthieu Lemoine and Jesper Lindé

This paper examines the effects of expenditure-based fiscal consolidation when credibility for the cuts to be long-lasting is imperfect. We contrast the impact limited credibility has when the consolidating country has the means to tailor monetary policy to its own needs, versus the case when it is a small member of a currency union with negligible impact on currency union interest rates and nominal exchange rates. We find two key results. First, under independent monetary policy, the adverse impact of limited credibility is relatively small, and consolidation can be expected to reduce government debt at a relatively low output cost given that monetary policy provides more accommodation that it would have to do under perfect credibility. Second, the lack of monetary accommodation under currency union membership implies that the output cost can be significantly larger, and that progress to reduce the government debt in the short- and medium-term is limited under imperfect credibility.

(continuing from previous year)

GROWTH

Fuel for Economic Growth
Johan Gars and Conny Olovsson

We set up an endogenous growth model in which the efficiency of both capital and fossil energy can be improved, whereas the efficiency of one alternative energy source is limited. With capital and energy as complements, there exist two steady states: one stagnant where energy is fully derived from the alternative energy source, and one with balanced growth where energy is fully sourced from fossil fuel. Heterogeneity in initial TFP levels can generate the Great Divergence. The demand for fossil fuel in technologically advanced countries drives up its price and makes fossil fuel too costly in less advanced countries that choose the alternative and stagnant energy input.

(continuing from previous year)

Energy-Saving Technical Change
John Hassler, Per Krusell and Conny Olovsson

We estimate an aggregate production function with constant elasticity of substitution between energy and a capital/labor composite using U.S. data. The implied measure of energy-saving technical change appears to respond strongly to the oil-price shocks in the 1970s and has a negative medium-run correlation with capital/labor-saving technical change. Our findings are suggestive of a model of directed technical change, with low short-run substitutability between energy and capital/labor but significant substitutability over longer periods through technical change. We construct such a model, calibrate it based on the historical data, and use it to discuss possibilities for the future.

(continuing from previous year)

HOUSEHOLD SAVING

Households' Housing and Borrowing Decisions
Joao Cocco, Tor Jacobson, Thomas Jansson, and Paolo Sodini

In this project we have access to a new unique micro dataset, which includes detailed information not only on a large sample of Swedish households' financial and real assets but also on their liabilities. In the dataset the exact composition of households' asset portfolios and the conditions of their debt (amounts, interest rates, variable or fixed rates, collateral etc.) are reported. We also have detailed income data, which enables us to estimate labor income volatility (separated into transitory and permanent components) at the individual level and at the household level. Hence, our dataset enables us to estimate a household's total exposure to various risk factors. The purpose of a first project is to use micro data to calibrate a lifecycle model. Our focus will be on how households' housing and borrowing decisions are affected by the evolution of house prices, labor incomes and mortgage interest rates. The predictions of the life cycle model will then be confronted with empirical results from estimated on the micro data.

(continuing from previous year)

How Parents Influence the Wealth Accumulation of their Children
Peter Englund, Thomas Jansson and Todd Sinai

We decompose the channels through which parents and children have correlated net worth using a novel administrative data set from Sweden that follows a panel of parents matched to their grown children. We find that children's initial endowments of net worth and their subsequent net worth accumulations are positively correlated with parents' net worth. There are two main channels of intergenerational wealth correlation. Children of wealthy parents have higher earnings, even conditional on intergenerational correlation in earnings, most of which they consume. The intergenerational correlation in net worth comes largely from housing wealth. We argue that arises from correlated home ownership among high net worth parents and their children, the propensity of home owners to save, and from children of high net worth parents spending more on housing at the time of first purchase. We also consider the impact of bequests, intervivos transfers, portfolio choice, and savings propensities.

(continuing from previous year)

Incompatible European Partners? Cultural Predispositions and Household Financial Behavior
Michael Haliassos, Thomas Jansson and Yigitcan Karabulut

The Eurozone fiscal crisis has created pressure for institutional harmonization, but skeptics argue that cultural predispositions can prevent convergence in behavior. Our paper derives a robust cultural classification of European countries and utilizes unique data on natives and immigrants to Sweden. Classification based on genetic distance or on Hofstede's cultural dimensions fails to identify a single 'southern' culture but points to a 'northern' culture. Significant differences in financial behavior are found across cultural groups, controlling for household characteristics. Financial behavior tends to converge with longer exposure to common institutions, but is slowed down by longer exposure to original institutions.

(continuing from previous year)

Uncertain Pension Income and Household Saving
Peter van Santen

I study the relationship between household saving and pensions, and estimate both the displacement effect of pensions on private saving and the precautionary saving effect due to uncertainty in pension income. In a lifecycle model, the consumption function depends on expected pension benefits and pension risk. I estimate the savings equation implied by the model using survey data for Dutch households, with subjective expectations on pension benefits and uncertainty. Exploiting exogenous variation due to pension fund performance, I show that savings decrease significantly with expected pension income, and that households save more due to uncertainty in pension income.

(continuing from previous year)

LABOR MARKETS

The Optimal Inflation Target under Downward Nominal Wage Rigidity
Mikael Carlsson and Andreas Westermark

We study the implications for optimal average inflation when there is both a role for money as a medium of exchange and when nominal wages are downwardly rigid. The model also features transaction costs, as in Dotsey, King & Wolman (1999), and a non-Walrasian labor market with search frictions as in Trigari (2009). The introduction of downward nominal wage rigidities into a model with flexible wages can be decomposed into two effects; first, introducing (symmetric) wage adjustment frictions and, second making them asymmetric. Productivity growth is important for the level of inflation and also affects the size of the effect of the asymmetric wage friction. Without productivity growth, symmetric wage adjustment frictions leads to a yearly inflation rate of approximately 1.0%, while introducing an asymmetry on top of this increases the inflation rate by an additional 0.7%. With productivity growth, inflation is almost a percent lower and the effect of adding asymmetric wage frictions is also somewhat smaller - about 0.5%. Overall, we find an optimal inflation rate of about 0-2 percent.

(continuing from previous year)

Labor Market Frictions and Optimal Steady-State Inflation
Mikael Carlsson and Andreas Westermark

In central theories of monetary non-neutrality, the Ramsey optimal steady-state inflation rate varies between the negative of the real interest rate and zero. This paper explores how the interaction of nominal wage and search and matching frictions affect the policy prescription. We show that adding the combination of such frictions to the canonical monetary model can generate an optimal inflation rate that is significantly positive. Specifically, for a standard U.S. calibration, we find a Ramsey optimal inflation rate of 1.15 percent per year.

(continuing from previous year)

Labor Market Frictions, the Long-Run Phillips curve and Optimal Monetary Policy
Mikael Carlsson and Andreas Westermark

The paper analyzes the Long- and Short-run Phillips curves in a model akin to the previous project. Specifically, we find a negative long-run relationship between inflation and unemployment. Moreover, we also analyze equilibrium dynamics under optimal monetary policy.

(continuing from previous year)

The Replacement Rate, Unemployment and Wage Setting
Vesna Corbo and Andreas Westermark

The project aims at empirically evaluating the effect of changes in the replacement rate on wage setting behavior and unemployment in a standard DSGE model incorporating firm-specific labor and bargaining between the firm and the workers with staggered wage and price contracts. Moreover, the relationship between the replacement rate and wage setting and unemployment will also be studied using reduced form IV methods that is standard in the literature to investigate whether general equilibrium DSGE models performs better than reduced form methods.

(continuing from previous year)

Fiscal Multipliers under Downward Nominal Wage Rigidity
Mikael Carlsson and Andreas Westermark

The purpose of this paper is to analyze whether fiscal multipliers are asymmetric in the presence of downward nominal wage rigidities. Specifically, spending shocks might have smaller effects on wages in recessions than in booms, implying that multipliers vary across the cycle.

(continuing from previous year)

Spillover Effects from Labor Mobility
Mikael Carlsson, Lena Hensvik, Oskar Nordstrom-Skans and Peter van Santen

We analyze labor flows between Swedish manufacturing firms, using a matched employer-employee data set covering Sweden between 1990 and 2002. We find that workers moving from more-productive firms to less-productive firms are associated with productivity gains for the receiving firms. In contrast, hiring from less-productive firms is neutral to productivity. The gains are especially large for engineers. The results are robust to a number of control variables, including firm fixed effects. The next step is to apply this method to the dataset covering the universe of firms and workers between 1990 and 2011.

(continuing from previous year)

The Aggregate Significance of Labor Reallocation
Susanto Basu, Mikael Carlsson and Peter van Santen

We analyze the impact of workers switching between firms on aggregate productivity growth. The GDP decomposition in Basu and Fernald (2002, European Economic Review) identifies the contributions of firm-level productivity growth, worker and capital flows and technological change on aggregate productivity growth and subsequently GDP. This paper quantifies the importance of worker reallocation on aggregate productivity growth. In a nutshell, worker flows boost GDP if high-productivity firms expand and low-productivity firms shrink. Our data spans the population of workers and firms in Sweden between 1997 and 2011, and allows us to match workers to firms. Separating out the firm-specific component of wages and under the assumption of cost minimization, we show that there is no systematic flow of workers towards high-productivity firms, resulting in a near-zero contribution of worker reallocation to aggregate productivity growth. This holds for both the aggregate economy, as well as for virtually all sectors of the economy in isolation. This result is in contrast with previous studies of the manufacturing sector, where between-firm reallocation is an important component of aggregate growth. Quantifying the methods used in previous studies shows that Sweden is no different when looking at market share reallocation, yet that whatever is causing between-firm growth is not due to labor flows. The lack of direction in labor flows is robust to various specifications of the marginal product of labor.

(continuing from previous year)

MACROECONOMICS

Welfare Costs of Energy Markups with Pollution Externalities
Christos Makridis and Conny Olovsson

We investigate the effect of market power among energy producers on the volatility of energy prices and pollution. First, we document the pro-cyclical nature of markups in the energy sector. Second, we develop a dynamic stochastic general equilibrium model with monopolistically competitive energy producers and auto-correlated shocks to both capital and energy productivity in order to understand the extent to which markups explain the observed volatility in energy prices and to implement a series of computational experiments. Calibrating the model and disciplining it to our estimated data on energy firms' markups, we

derive the optimal policy for managing both pollution externalities and market power. We show that only addressing one of these externalities at the expense of another can impose large welfare costs.

(continuing from previous year)

Job Displacement and the Cost of Business Cycles
Karl Walentin and Andreas Westermark

In this paper we explore a new mechanism generating welfare cost of business cycles. We show that cyclical variation in the unemployment rate reduces the aggregate level of output and welfare. Our mechanism concerns the earnings losses generated by job displacement. It has been broadly established that this type of earnings losses are large. We rely on the empirical results of Davis and von Wachter (2011) who document that the frequency of job displacement is countercyclical and that earnings losses are increasing in the unemployment rate. We model the above phenomenon in a general equilibrium framework which accounts for heterogeneity on both the firm and worker side. We quantify the effect of business cycles and find that they reduce GDP by 1.5%.

(continuing from previous year)

The Macro-Financial Implications of House Price-Indexed Mortgage Contracts
Isaiah Hull

I explore an alternative mortgage contract that limits negative equity by tying outstanding debt to an index of house prices. This is done in an incomplete markets model that is calibrated to match US micro- and macro-data. I find that switching from a non-recourse contract to an indexed contract reduces the default rate from .72% to .11% and expands homeownership rates among the young and the poor but pushes up the equilibrium base mortgage rate by 90 basis points. The volatility of net cashflows to financial intermediaries also increases slightly under the new contract.

(accepted for publication)

Amortization Requirements and Household Indebtedness: An Application to Swedish-Style Mortgages
Isaiah Hull

Since the mid-1990s, many OECD countries have experienced a substantial increase in household indebtedness. Sweden, in particular, has seen indebtedness rise from 90% of disposable income in 1995 to 172% in 2014. The Swedish Financial Supervisory Authority (FSA) has identified mortgage amortization requirements as a potential instrument for reducing indebtedness; and has drafted guidelines that will intensify the rate and duration of amortization. In this paper, I characterize Swedish-style mortgage contracts, which differ substantially from U.S.-style contracts. I then evaluate the policy changes in an incomplete markets model with three types of debt and a novel mortgage contract specification that is calibrated to match Swedish micro and macro data. I find that intensifying the rate and duration of amortization is largely ineffective at reducing indebtedness in a realistically-calibrated model. In the absence of implausibly large refinancing costs or tight restrictions on the maximum debt-service-to-income ratio, the policy impact is small in aggregate, over the lifecycle, and across employment statuses. These results may be relevant for other OECD countries, such as Norway and Canada, that have also not seen a reduction in house prices or indebtedness since the 2007 financial crisis.

What Broke First? Characterizing Sources of Structural Change Prior to the Great Recession
Isaiah Hull

This paper identifies and characterizes episodes of structural change in the 27 years that preceded the Great Recession. This is done by performing Bai-Perron (2003a, 2003b) tests on 61,843 time series that span 34 countries. Three major stylized facts are established. First, the pace of structural change spiked twice between the 1990-1991 and 2007-2009 recessions: once in 1993-1994 and again in 2001-2003. The 1993-1994 spike was most closely associated with consumption and investment breaks; whereas, the 2001-2003 spike also included structural change in net exports. Second, the rate of structural change in exchange rates, interest rates, and residential prices all peaked between 2001 and 2004. And third, the timing of structural breaks differed sharply across country-groups between 1990 and 2006. Countries that experienced both a housing boom and bust prior to the Great Recession saw structural change in credit, interest rates, and construction costs during the early-to-mid 1990s. Countries that experienced a boom, but not a bust, saw similar, but delayed structural change in interest rates; and experienced an increase in structural change to construction costs and credit from 1999 to 2006. Countries that experienced neither had flatter structural

change profiles for the same variables during the 1990s. Unlike the first two groups, countries with neither a boom nor a bust did not experience spikes in either structural change to investment or to joint breaks with the U.S. in the late 1990s and 2001.

Jump-Starting the Euro Area Recovery: Should the Core Expand Spending to Help the Periphery?
Olivier Blanchard, Christopher Erceg and Jesper Lindé

We show that a fiscal expansion by the core economies of the euro area would have a large and positive impact on periphery GDP assuming that policy rates remain low for a prolonged period. Under our preferred model specification, an expansion of core government spending equal to one percent of euro area GDP would boost periphery GDP around 1 percent in a liquidity trap lasting three years, about half as large as the effect on core GDP. Accordingly, under a standard ad hoc loss function involving output and inflation gaps, increasing core spending would generate substantial welfare improvements, especially in the periphery. The benefits are considerably smaller under a utility-based welfare measure, reflecting in part that higher net exports play a material role in raising periphery GDP.

(continuing from previous year)

MONETARY POLICY AND THEORY

A Note on Nominal GDP Targeting and the Zero Lower Bound
Roberto Billi

I compare nominal GDP level targeting to strict price level targeting in a small New Keynesian model, with the central bank operating under optimal discretion and facing a zero lower bound on nominal interest rates. I show that, if the economy is only buffeted by purely temporary shocks to inflation, nominal GDP level targeting may be preferable because it requires the burden of the shocks to be shared by prices and output. However, in the presence of persistent supply and demand shocks, strict price level targeting may be superior because it induces greater policy inertia and improves the tradeoffs faced by the central bank. During lower bound episodes, somewhat paradoxically, nominal GDP level targeting leads to larger falls in nominal GDP.

(accepted for publication)

Price Level Targeting and Risk Management
Roberto Billi

Many argue that, in the presence of a lower bound on nominal interest rates, central banks should use a risk management approach for setting policy, which implies committing to a more expansionary policy to deal with uncertainty about the economic recovery. Using a standard model for monetary policy analysis, I study the effects of an uncertain future for both price level targeting and nominal GDP level targeting. The results clarify that, during lower bound episodes, the extent to which policy can overcome uncertainty depends crucially on the choice of policy framework.

Output Gaps and Robust Monetary Policy Rules
Roberto Billi

Policymakers often use the output gap, a noisy signal of economic activity, as a guide for setting monetary policy. Noise in the data argues for policy caution. At the same time, the zero bound on nominal interest rates constrains the central bank's ability to stimulate the economy during downturns. In such an environment, greater policy stimuli may be needed to stabilize the economy. Thus, noisy data and the zero bound present policymakers with a dilemma in deciding the appropriate stance for monetary policy. I investigate this dilemma in a small New Keynesian model, and show that policymakers should pay more attention to output gaps than suggested by previous research.

(continuing from previous year)

Optimal Inflation with Corporate Taxation and Financial Constraints
Daria Finocchiaro, Giovanni Lombardi, Caterina Mendicino and Philippe Weil

This paper revisits the equilibrium and welfare effects of long-run inflation in the presence of distortionary taxes and financial constraints. Expected inflation interacts with corporate taxation through the deductibility of (i) capital expenditures at historical value and (ii) interest payments on debt. Through the first channel, inflation increases firms' taxable profits and further distorts their investment decisions. Through the second,

expected inflation affects the effective real interest rate, relaxes firms' financial constraints and stimulates investment. We show that, in the presence of collateralized debt, the second effect dominates. Therefore, in contrast to earlier literature, we find that when the tax code creates an advantage of debt financing, a positive rate of long-run inflation is beneficial in terms of welfare as it mitigates the financial distortion and spurs capital accumulation.

(continuing from previous year)

Debt, Equity and the Equity Price Puzzle
Daria Finocchiaro and Caterina Mendicino

We show that in a model with equity and debt financing, the specification of the borrowing constraint is crucial to generate empirically plausible responses of both macro variables and asset prices in response to a financial shock. Key to the result is the interaction between financial frictions and labor demand, as in Jermann and Quadrini (2012). By incorporating a working capital assumption also a collateral constraint à la Kiyotaki and Moore (1997) generates similar results on impact.

Seigniorage, Gesell Taxes and Monetary Policy in the Middle Ages
Roger Svensson and Andreas Westermark

Gesell taxes on money holdings have received attention in recent decades as a way of alleviating the zero lower bound on interest rates. Less known is that such a tax was the predominant method used to generate seigniorage in large parts of medieval Europe for around two centuries. When the Gesell tax was levied, current coins ceased to be legal tender and had to be exchanged into new coins for a fee - an institution known as renovatio monetae or periodic re-coinage. This could occur as often as twice a year. Using a cash-in-advance model, prices increase over time during an issue period and falls immediately after the re-coinage date. Agents re-mint coins and the system generates tax revenues if the tax is sufficiently low, if the time period between re-coinages is sufficiently long, and if the probability of being penalized for using illegal coins is sufficiently high.

(continuing from previous year)

Challenges for Macro Models Used at Central Banks
Jesper Lindé, Frank Smets and Rafael Wouters

This paper discusses the current state of play for macroeconomic models used by central bank and other large international organizations. We analyse the key challenges the recent "great recession" in the United States and Europe poses for the future generation of policy models.

Designing a Simple Loss Function for the Fed: Does the Dual Mandate Make Sense?
Davide Debortoli, Jinill Kim, Jesper Lindé and Ricardo Nunes

Yes, it makes a lot of sense. Using the Smets and Wouters (2007) model of the U.S. economy, we find that the role of the output gap should be equal to or even more important than that of annualized inflation when designing a simple loss function to represent household welfare. The high weight on the output gap is driven by several important characteristics in the estimated model, including a low elasticity of substitution between monopolistic goods, price indexation, and sticky wages. Moreover, we document that a loss function with nominal wage inflation and the hours gap provides an even better approximation of the true welfare function than a standard objective based on inflation and the output gap. Our results hold up when we introduce interest rate smoothing in the simple mandate to capture the observed gradualism in policy behavior and to ensure that the probability of the federal funds rate hitting the zero lower bound is negligible.

(continuing from previous year)

On the Theoretical Efficacy of Quantitative Easing at the Zero Lower Bound
Paola Boel and Christopher J. Waller

We construct a monetary economy in which agents face aggregate demand shocks and heterogeneous idiosyncratic preference shocks. We show that, even when the Friedman rule is the best interest rate policy the central bank can implement, not all agents are satiated at the zero lower bound and therefore there is scope for central bank policies of liquidity provision. Indeed, we .find that quantitative easing can be welfare improving even at the zero lower bound. This is because such policy temporarily relaxes the liquidity constraint of impatient agents, without harming the patient ones. Moreover, due to a pricing externality, quantitative easing may also have beneficial general equilibrium effects for the patient agents even if they

are unconstrained in their holdings of real balances. Last, our model suggests that it can be optimal for the central bank to buy private debt claims instead of government debt.

(continuing from previous year)

Redistributive Effects of Inflation in a Model of Money and Capital
Paola Boel and Julián P. Díaz

We introduce heterogeneity in trade risk in a microfounded model of money with capital, thus inducing a distribution in both cash and capital holdings. We then calibrate the model for a subsample of OECD countries. In doing so, we address the following questions: What are the redistributive effects of inflation? How does the nature of the asset held affect the direction of the redistribution? Does inflation act as a progressive tax when a productive asset is held? Do results hold across OECD countries? Several results hold for all countries considered. First, inflation acts as a tax on two fronts, in that it reduces both real cash balances and capital accumulation. Second, inflation is a progressive tax which hurts rich, high-consumption agents more than it does poor, low-consumption ones. Third, the magnitude of the redistributive effects differs across countries and depends on the distributions of capital and liquid asset holdings.

(continuing from previous year)

Money, Credit and the Redistributive Effects of Inflation
Paola Boel and Daria Finocchiaro

We construct a microfounded model of money with heterogeneity in discounting and trading risk. Agents can insure against this risk with money and have also access to financial markets that issue via inter-period contracts. A form of limited participation in financial markets leads to both coexistence of money and credit in the economy and heterogeneity in money and debt holdings. The model is then utilized to quantitatively assess the effects of debt on the redistributive effects of inflation.

Using Monetary Policy to Promote Financial Stability - a Cost-Benefit Analysis
David Vestin

The project is aimed at quantifying the gain from leaning against the wind with monetary policy. The risk of a financial crisis is affected by real credit growth, which is in turn affected by monetary policy. Short-run costs of lower inflation and higher unemployment are balanced against a reduction in the probability of a crisis, which leads to less risk of a bad macroeconomic outcome in the future. Preliminary results suggest that while higher interest rates do reduce the likelihood of a crisis, the short run costs of using monetary policy outweigh the expected gain, in the benchmark calibration.

Publications accepted in 2015

Billi, Roberto M., "A Note on Nominal GDP Targeting and the Zero Lower Bound," *Macroeconomic Dynamics*, forthcoming

Degryse, Hans, Vasso Ioannidou and Erik von Schedvin," On the Non-Exclusivity of Loan Contracts: An Empirical Investigation", *Management Science*, forthcoming

Hull, Isaiah, "Approximate dynamic programming with post-decision states as a solution method for dynamic economic models", *Journal of Economic Dynamics and Control*, Vol. 55, pp. 50-57

Hull, Isaiah, "The Macro-Financial Implications of House Price-Indexed Mortgage Contracts", *Economics Letters*, Vol. 127, pp. 81-85

Hull, Isaiah, "The Development and Spread of Financial innovations", *Quantitative Economics*, forthcoming

Jacobson, Tor, and Erik von Schedvin, "Trade Credit and the Propagation of Corporate Failure: An Empirical Analysis", *Econometrica*, Vol. 83, pp. 1315-1371

Lucas, André, Bernd Schwaab and Xin Zhang, "Modeling Financial Sector Joint Tail Risk in the Euro Area", *Journal of Applied Econometrics*, forthcoming

Lucas, André, and Xin Zhang, "Score Driven Exponentially Weighted Moving Averages and Value-at-Risk Forecasting", *International Journal of Forecasting*, forthcoming

Working papers

No. 314, Daria Finocchiaro and Caterina Mendicino, "Debt, Equity and the Equity Price Puzzle"

No. 313, Michael Böhm, Daniel Metzger, and Per Strömberg, "Since You're so Rich, You Must Be Really Smart: Talent and the Finance Wage Premium"

No. 312, Christoph Bertsch and Mike Mariathasan, "Fire Sale Bank Recapitalizations"

No. 311, Daria Finocchiaro, Giovanni Lombardo, Caterina Mendicino and Philippe Weil, "Optimal Inflation with Corporate Taxation and Financial Constraints"

No. 310, Paola Boel and Christopher J. Waller, "On the Theoretical Efficacy of Quantitative Easing at the Zero Lower Bound"

No. 309, André Lucas and Xin Zhang, "Score Driven Exponentially Weighted Moving Averages and Value-at-Risk Forecasting"

No. 308, André Lucas, Bernd Schwaab and Xin Zhang, "Modeling Financial Sector Joint Tail Risk in the Euro Area"

No. 307, Matias Quiroz, "Speeding up MCMC by Delayed Acceptance and Data Subsampling"

No. 306, Matias Quiroz, "Scalable MCMC for Large Data Problems Using Data Subsampling and the Difference Estimator"

No. 305, Eric M. Leeper and James M. Nason, "Bringing Financial Stability into Monetary Policy"

No. 304, Olivier Blanchard, Christopher J. Erceg and Jesper Lindé, "Jump-Starting the Euro Area Recovery: Would a Rise in Core Fiscal Spending Help the Periphery?"

No. 303, Ferre De Graeve and Jens Iversen, "Central Bank Policy Paths and Market Forward Rates: A Simple Model"

No. 302, Roberto Billi, "Price Level Targeting and Risk Management"

No. 301, Isaiah Hull, "What Broke First? Characterizing Sources of Structural Change Prior to the Great Recession"

No. 300, Jungsuk Han and Francesco Sangiorgi, "Searching for Information"

No. 299, Johan Gars and Conny Olovsson, "Fuel for Economic Growth?"

No. 298, Isaiah Hull, "Amortization Requirements and Household Indebtedness: An Application to Swedish-Style Mortgages"

No. 297, Matias Quiroz, Mattias Villani and Robert Kohn, "Speeding up MCMC by Efficient Data Subsampling"

No. 296, Jaap W.B. Bos and Peter C. van Santen, "The Importance of Reallocation for Productivity Growth: Evidence from European and U.S. Banking"

No. 295, Rafael B. De Rezende, "Risks in Macroeconomic Fundamentals and Excess Bond Returns Predictability"

No. 294, Toni Ahnert and Christoph Bertsch, "A Wake-Up Call Theory of Contagion"

Non-refereed publications in 2015

Should Tax Rates on Goods and Services Be Equal?
Paul Klein and Conny Olovsson
Ekonomisk Debatt 3, 2015

In this article, we try to answer whether it is a good idea to have different tax rates on goods and services. Our answer is that, from a social point of view, it is well motivated to implement lower tax rates on services than on goods and, in particular, on goods that are used in home production. The analysis departures from a new contribution to the literature on optimal taxation that acknowledges that taxes on services can be avoided through home production.

An Analysis of the Fixation Period for Swedish Mortgages
Ulf Holmberg, Hannes Janzén, Louise Oscarius, Erik Spector and Peter van Santen
Economic Commentaries 7, 2015

Recently, it has become increasingly common for Swedish households to opt for variable interest rates for their mortgages. In this economic commentary, households' choice of fixation periods, the banks' mortgage funding and the risks posed by households' choice of fixation periods are discussed. The study shows that short fixation periods are common both in Sweden and in other countries, and it is probably household preferences that determine the fixation period for Swedish mortgages, rather than the banks. It appears that households take account of both the future interest rate level in the short term (one-year rate expectations) and present relative expenses (the spread between fixed and variable mortgage rates) when they choose between variable or fixed mortgage rates. The study also shows that the historical variation in inflation affects the share of new lending at short fixation periods. In this study, we also analyse the choice of Swedish households of fixation period using microdata regarding new borrowers. The analysis shows that it is households with high income and low debts that are most inclined to choose variable rates for their mortgages. This confirms the results from previous theoretical studies that have shown that households with a high, stable income ought to be more inclined to opt for variable-rate mortgages.

Effects of Unconventional Monetary Policy: Theory and Evidence
Ferre De Graeve and Jesper Lindé
Penning och Valutapolitik 1, 2015

The paper analyses the central bank's possibilities for using unconventional monetary policy measures when inflation is low and the policy rate has approached its lower limit. They study experiences abroad and use a macroeconomic model for various simulations. One alternative they study involves the central bank announcing (providing guidance) that the policy rate will remain low for longer than normal. If the decision is deemed credible by households and companies, monetary policy will immediately become more expansionary, contributing to rising inflation. Another alternative involves the central bank purchasing government and/or corporate bonds for longer maturities. This can contribute to lower term and risk premiums, thus making monetary policy more expansionary. In both alternatives, lower interest rates relative to those abroad may also contribute towards weakening the exchange rate, which increases import prices and normally leads to increased inflation. Similar conclusions are obtained from empirical studies, which indicate that unconventional measures can be used as a complement to conventional monetary policy interventions when inflation and the policy rate are very low.

The Riksbank's Future Information Supply in Light of Big Data
Jyry Hokkanen, Tor Jacobson, Cecilia Skingsley, and Markus Tibblin
Economic Commentaries 17, 2015

The concept of Big Data refers to the extremely large amounts of data that can now be retrieved and stored thanks to various technical breakthroughs. The concept of Big Data also includes streaming data and non-traditional data such as text. These data are often complex and in many cases unstructured, which means that they normally have to be processed and analysed using special methods. The management of large datasets is nothing new; it has been done by both researchers and statisticians for a long time. Nowadays, however, there are better technical solutions we can use to gather, store, structure and analyse increasingly large amounts of complex data, including all the new data generated by our presence on the Internet. This, in turn, creates the potential to manage structure and extract knowledge from large, streaming or non-traditional datasets in a way that was previously impossible. Big Data is a data revolution which will also affect how central banks use and analyse data. Aggregated time series data, published with a time-lag, has traditionally been used to follow economic development. Non-traditional data could further improve our

understanding of economic development. If such data also is continuously observed, decision-makers can react more quickly to changes in development. However, in order for authorities like the Riksbank to able to benefit from these new, rapidly growing datasets, a well-considered strategy is required, based on the premise that data is a strategic resource. The data revolution challenges traditional thinking not just regarding data capture and analysis; it also requires new skills, new technology and a fit-for-purpose organisation.

Other research activities

Conferences

The Research Division organized a conference on deflation in June 2015. The conference covered the causes and economic consequences of deflation, as well as the policies that can mitigate such consequences. The organizing committee consisted of Jesper Lindé, Karl Walentin and Andreas Westermark, all from the Riksbank. The program with presentations and articles is available at http://www.riksbank.se/en/The-Riksbank/Research/Conferences/2015/Program/.

In November, a two-day policy workshop on the theme "Integrating financial stability into monetary policy decision-making – the modelling challenges" was hosted by the Riksbank, jointly organized by David Vestin together with the BIS.

Courses

The Research Division organized a second-year PhD course on monetary economics. The course was held at the bank, and was taught by faculty from Stockholm University and Riksbank's researchers. The purpose was to introduce students to modern New Keynesian models for monetary policy and business cycle-analysis.

Greater Stockholm Macro Group

Together with Per Krusell (IIES, Stockholm University), we continue to organize a monthly internal seminar series for macro researchers from all major institutions in Stockholm and Uppsala. The series is known as "Greater Stockholm Macro Group" and aims at fostering exchange of ideas and cooperation among macro researchers in the Stockholm area.

Research Seminars

The Research Division organizes weekly research seminars, mainly by invited international visitors. The seminars normally take place on Tuesdays at 1 pm and attendance is open to Riksbank employees as well as to all academics. A complete list of both upcoming and past seminars is available on the homepage of the Riksbank's Research Division.

Internship Program

As customary, the Research Division hosted four PhD interns in 2015. This year's interns were Ding Ding (Royal Institute of Technology), Anders Österling (Stockholm University), Markus Sigonius (Stockholm School of Economics) and Yimei Zou (Pompeu Fabra University).

Teaching and Advising

Daria Finocchiaro taught half of the first-year graduate macro course at Uppsala University in the fall. Her lectures dealt with classical consumption theory, asset prices and overlapping generation models, while also touching upon fiscal and monetary policy issues. She also served as a member on the PhD grading committee for Simon Wehrmüller at the Stockholm School of Economics and as opponent for Mathias Pronin's licentiate defense at Stockholm University. Karl Walentin taught half of the Macro II class for PhD students at Stockholm University and advised one PhD student at Uppsala University. Andreas Westermark taught part of the second-year PhD course on monetary economics. Matias Quiroz taught part of a master/PhD course in Bayesian Statistics at Stockholm University. Conny Olovsson taught the master's course "The climate and the economy" at Stockholm University during the spring. Jesper Lindé taught a master course in monetary policy at the Stockholm School of Economics.

Miscellanea

Christoph Bertsch was in the program committee for the 2015 Financial Safety Net Conference in Stockholm.

Upcoming events in 2016

The Research Division is planning a conference on financial interconnectedness in September 2016. The conference will focus on the risks and benefits of financial linkages, as well as implications for financial market regulation. The organizing committee consists of Tor Jacobson, Thomas Jansson, Peter van Santen and Xin Zhang, all from the Riksbank. As now customary, the division is also organizing a second-year PhD course on monetary economics.

Interview with Eric M. Leeper (continuing from page 1)

The value to me runs in two directions: sometimes I learn that the academic approach has little to inform policy, while at other times I learn that the policy approach doesn't hang together logically or economically. It is seeing issues from both sides that, I think, makes me a better economist.

Another dimension to the job as advisor is that I am asked to grapple with issues that are outside my expertise. It is always tempting for a researcher to stay within the friendly confines of what the researcher already knows. But actual policymaking is often about going well outside those bounds. For example, one of the first projects that the Riksbank asked me to undertake, in 2003 I think, was to evaluate what at the time was called the Riksbank's *Inflation Report*. Up to that time, I had not carefully read a wide range of central bank *Reports*, so it was a new experience to me. My reading led to a deeper understanding of what central banks aim to do and how they do it. Because the Riksbank staff has always solicited my unvarnished opinions, I had free reign to write exactly what I thought about the *Report*. At times, I was critical, but I also tried to be constructive. Being constructive forces me to be a better economist.

Last year's project took me well outside my comfort zone: help the Riksbank think about how to bring financial stability into monetary policy analyses and decisions. I am not a banking or finance person, so I was apprehensive about this project. Thankfully, the Riksbank permitted me to work with Jim Nason at North Carolina State University and that made all the difference. In the process of writing our report, Jim taught me a lot about financial markets, instruments, and history; those lessons opened my mind to a great many fresh research ideas. Once again, the outcome was to make me a better economist.

That's why I continue to advise the Riksbank: it is an opportunity to broaden and hone my skills as an economist. And, to be honest, it is also gratifying to be told that some things you have to say are useful.

2. *Why and how do you think the global financial crisis has strained the tenability of a policy approach which focuses solely on monetary policy and abstracts from fiscal policy?*

For many years, some of us have been preaching the need to study monetary and fiscal policies jointly. During the "good years," when inflation targeting seemed to be delivering reasonable economic performance coupled with low and stable inflation rates, those sermons fell on deaf ears. Folks acknowledged that this argument was true *in principle*, but was little more than a footnote *in practice*. Practical monetary policymaking, it seemed, could proceed by treating monetary policy choices as independent of fiscal actions and relying on fiscal authorities to "do the right thing" by adjusting taxes and spending as needed to maintain a stable ratio of government debt to GDP.

The financial crisis changed everything. Severe recession, combined with additional fiscal stimulus, drove debt-GDP ratios to peacetime highs in most countries. (Sweden is a notable exception.) At the same time, once central banks had reduced policy interest rates to near zero, they turned to unconventional asset-purchasing actions that exploded central bank balance sheets. Some of those unconventional actions smacked of fiscal policy in a couple of ways. First, when central banks purchase *private* assets—rather than government bonds, as they usually do—monetary policy is engaging in a kind of credit allocation. Central banks like to think that their decisions do not have important allocative consequences; that monetary policy focuses on aggregates, not how the aggregates are divided up. Although this is always a fiction, during the crisis the fiction was no longer tenable.

Second, when central bank assets shifted from holding traditional short-term government bonds to buying private assets and long-term government bonds, their balance sheets became riskier. A riskier balance sheet brings fiscal policy directly into the picture. The complete explanation of this is a bit involved, so let me just leave it that if the central bank is not assured fiscal backing or fiscal support, to use the terminology in Del Negro and Sims (2015), then its ability to hit its inflation target may be jeopardized.

Of course, the conventional approach to monetary policy, which sweeps fiscal behavior under the carpet by assuming it will "do the right thing," is completely silent on these two dimensions along which monetary and fiscal policy interact during the crisis and recovery.

3. *Which types of models do you think we need to produce a deeper understanding of the way monetary and fiscal policy affect the economy?*

For some deeper understandings, we do not require wholly new models. We just need to fill in the details on the fiscal side. For example, one could take a model like RAMSES II and, instead of assuming away fiscal policy, modify it by estimating rules that determine taxes, government spending, and the level of outstanding government debt. Modelers in Sweden have the great advantage that those fiscal rules are, in principle, constrained by Sweden's fiscal policy framework, which entails a surplus target for net government lending. (I say an advantage because in many countries, fiscal rules are not motivated by any explicit fiscal framework, much less a surplus-targeting policy, so the modeler is very much in the dark about the goals and nature of fiscal policy.) Of course, one would want to investigate whether, in fact, Swedish fiscal policy behavior actually seems to obey such a targeting policy.

Once these fiscal details are embedded in the model, you are well on the way toward deeper understandings. You can ask about the range of possible equilibria that can arise under alternative assumptions about monetary and fiscal behavior. You can ask, given the fiscal rules, how fiscal variables react to various shocks that hit the economy, including actions that the Riksbank takes. In a model with certain kinds of financial restrictions that break down Ricardian equivalence—the proposition that whether government spending is financed by debt or taxes makes no difference for economic outcomes—even more interesting interactions between monetary and fiscal policies may emerge. For example, if fiscal disturbances affect real economic activity and inflation, then it's likely that monetary policy will directly respond to fiscal actions, so the interactions work in both directions.

4. *What are the limitations of representative-agent models when we want to think about financial stability? Is the heterogeneity aspect especially important when we think of the possible implications of high levels of private indebtedness?*

Treating the economy as if it is populated by a single kind of economic agent severely limits how richly one can interpret financial conditions. After all, financial transactions entail trade: one person's saving is another person's borrowing. When everyone is identical, no trade occurs. A summary measure like total household indebtedness as a share of income combines the behavior of highly diverse borrowers. Some borrowers may be very wealthy and perfectly capable of repaying their debts, while others are living hand-to-mouth and on the cusp of default. We learned this during the financial crisis when defaults in the United States were triggered initially by sub-prime mortgages. Any accurate assessment of the precariousness of the level of household indebtedness needs to dig into the data to understand how fragile the situation really is. And this information could have important policy implications: if the problems lie primarily with a subset of borrowers, then policy interventions can target those individuals, rather than bluntly affecting the entire economy.

Heterogeneity also enhances the understanding of fiscal policy. After all, there are many kinds of taxes and government spending that affect different people differently. Redistributional implications of fiscal actions cannot be studied in representative-agent environments.

Heterogeneity brings us back to the issue of redistribution. Any central bank that is deeply engaged in financial stability considerations is necessarily getting involved in redistribution. This is true even at the blunt level of monetary policy. For example, higher interest rates that aim to discourage household borrowing will affect some borrowers more than others. In fact, that's the point of raising interest rates—to discourage the marginal borrowers from accumulating more debt and, perhaps, to get them to deleverage.

As I said earlier, this is a tricky business for a central bank because in a democracy we usually place distributional issues in the hands of elected officials, rather than appointed technocrats. (I hasten to add that I am forming no judgment about which hands are more competent.)

5. *You have recently been involved with launching a new research network – the 'trinity network'. What are its objectives? Which types of questions does it aim to address and with which type of models?*

This is a project with Markus Brunnermeier at Princeton under the auspices of the German Bundesbank, where Markus and I serve on the research council. Trinity reflects the three major aims of macroeconomic policy: stability in prices, financial markets, and government debt. So it necessarily brings together monetary, financial, and fiscal policies.

We have some theory to help us think about how monetary and fiscal policy interact. We have essentially no theory that brings financial policies into the picture. The project aims to fill that void. This is a long-term project, of course, so the hope is that the network will make incremental progress, perhaps first developing useful frameworks to integrate monetary and financial policies, treating fiscal policy as "doing the right thing." Then we can bring in fiscal policy to understand how it changes perspective. If the history of theoretical developments is a guide, it is quite likely that integrating fiscal policy will expand the set of possible equilibria in interesting ways.

Perhaps I should explain why the integration of fiscal policy is important to this project. First, there is the point I raised earlier that central bank actions designed to stabilize financial markets during the crisis looked a lot like fiscal actions. Those actions need to be modeled explicitly. Second, policy actions like lender-of-last-resort are intrinsically fiscal and any study of financial stability has to include lender-of-last-resort. As we saw in the United States, financial stability policies with large fiscal consequences trigger political economy dynamics. Third, older monetary theory by researchers like James Tobin, Karl Brunner, and Allen Meltzer emphasized the macroeconomic consequences of credit creation and expansion of "inside money." This dimension of monetary theory has largely fallen to the wayside in recent decades, so we have no models that inform about how credit creation affects inflation. But in advanced economies, government debt plays an important role in credit creation as a source of collateral. Useful models of credit creation, therefore, will ascribe a central role to debt management choices. In sum, it is difficult to see how to make substantial progress on understanding the monetary policy-financial stability nexus without fully integrating fiscal policy.

A novel aspect of the trinity network is that we conceived it from the beginning as a vehicle for bringing together academic and policy researchers. Interplay between economists with different perspectives creates synergies for both parties: academics learn about the issues and the institutional features that concern policymakers, while policy analysts learn frontier analytical and empirical methods from the academics. The goal is to produce analytical frameworks that are both at the research frontier and informative to policymakers.

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