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This newsletter describes the research activities and output of the Research Division at Sveriges Riksbank in 2018.

## Staff at the Research Division, 2018

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## Reflections by the head of research

It's the end of another year, and time to pass around our exciting outlet Research News! In retrospect, the year just flew by. Still, when looking back – it contained one highlight above all during my tenure at the Riksbank: the Riksbank celebrating its 350-years anniversary!

Although the Riksbank is the world's oldest central bank, it is now a modern central bank with operations that are constantly being developed to promote economic stability and highest sustainable growth in Sweden.

During the anniversary year, the Riksbank organized several activities both for specially invited guests and for the general public, in Stockholm and all over Sweden. The highlight for us in the Research division was the special anniversary conference "The role of central banks then, now and in the future" that took place in the Sveriges riksdag (Swedish Parliament) in Stockholm on 25 May 2018.

In the morning, Torsten Persson delivered a lecture "The political economy of the Riksbank", in which he describes important historical reforms of Sweden's monetary institutions to ensure price stability and a safe and efficient payment system. The lecture is a stepping stone in modern institutional economics, where institutional reforms are seen as the result of large and important events, or of conflicts of interest, and was published in the September issue of our *Economic Review*. It is a great holiday read. In the afternoon, the anniversary book *Sveriges Riksbank and the History of Central Banking* was presented and discussed. The book contains 14 research chapters in which very prominent economists give the reader an overall picture of the history of central banking in key countries and currency areas, with the main focus on the Riksbank. The book was edited by Rodney Edvinsson, Daniel Waldenström, and the Research divisions' Tor Jacobson. It is also a highly recommended reading, and this issue features an exclusive interview with Charles Goodhart, one of the book's contributors.

Even though the Riksbank has a long and impressive 350-year history, old age in itself does not make it great – what makes it an interesting place to be and among the best central banks in the world is the knowledgeable and dedicated staff. During the year that has passed, the Research Division has made important contributions to many key issues. And in case you, Dear Reader, are able to take some time and look through our Research News, I'm sure you will recognize the depth and breadth of our work. This year, our featured article is Karl Walentin's paper "Financial frictions, investment, and Tobin's q" that has just been accepted for publication in the *Journal of Monetary Economics*.

With this, I'm over and out. I wish you a good read of our News, happy holidays and a productive and successful 2019!

*Jesper Lindé*

## Interview with Charles Goodhart

Professor Emeritus, London School of Economics

This year, 2018, the Riksbank has celebrated the continuous operation of an institution started in 1668. There have been many activities undertaken by the bank to this end, in Stockholm and elsewhere in the country. Just to mention a

few: the Riksbank opened up its otherwise closed doors to the general public and lots of people took the opportunity to learn more about what is actually going at the premises and what the Riksbank hopes to contribute towards; a one-day jubilee conference took place in parliament – the Riksbank’s principal – with central bankers and academics from across the globe participating and discussing the past and future challenges to central banking; and finally, a book was written up with the purpose of describing the evolution of twelve central banks: “Sveriges Riksbank and the History of Central Banking,” Cambridge University Press. Many prominent scholars contributed to this volume; not least Professor Charles Goodhart, who accepted the challenge to once again present the celebrated history of the Bank of England and did so in a new and very interesting way.

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## Changes in the research staff

**Paolo Giordani** left the research division to work as an Associate Professor at BI Norwegian School of Business. In October 2018, **Mats Levander** successfully defended his PhD dissertation at Stockholm School of Economics, and transitioned from the research division to the financial structure division in the financial stability department. **Matias Quiroz** left the research division for a position as a postdoctoral research fellow at the School of Economics, UNSW Business School at the University of New South Wales. **Jessica Radeschnig** left the position as research assistant for a position as actuary at Länsförsäkringar. **Jesper Böjeryd** left the research division to first start as a research assistant at Stockholm School of Economics and then moved on to the PhD program in economics at UCLA.

## Summary of featured article

The following is a summary of the article “Financial Frictions, Investment and Tobin’s  $q$ ” by Dan Cao, Guido Lorenzoni and Karl Walentin, which has been accepted for publication in *Journal of Monetary Economics*. An earlier version of the article was part of Karl Walentin’s PhD dissertation at New York University quite some time ago.

Dynamic models of the firm imply that investment decisions and the value of the firm should both respond to expectations about future profitability of capital. In models with constant returns to scale and convex adjustment costs these relations are especially clean, as investment and the firm’s value respond exactly in the same way to new information about future profitability. This is the main prediction of Tobin’s  $q$  theory, which implies that current investment moves one-for-one with  $q$ , the ratio of the firm’s financial market value to its capital stock. This prediction, however, is typically rejected in the data, where investment appears to correlate more strongly with current cash flow than with  $q$ .

In this paper, we investigate the relation between investment,  $q$ , and cash flow in a model with financial frictions. The presence of financial frictions introduces quasi-rents in the market valuation of the firm. These quasi-rents break the one-to-one link between investment and  $q$ . We study how the presence of these quasi-rents affects the correlations between investment,  $q$ , and cash flow, and ask whether a model with financial frictions can match the correlations in the data.

Our main conclusion is that the presence of financial frictions can bring the model closer to the data, but that the model’s implications depend crucially on the shock structure. In a model with financial frictions it is still true that investment and  $q$  respond to future profitability, but the two variables now respond differently to information at different horizons. Investment is particularly sensitive to current profitability, which determines current internal financing, and to near-term financial profitability, which determines collateral values. On the other hand,  $q$  is relatively more sensitive to profitability farther in the future, which will determine future growth and thus the size of future quasi-rents. Therefore, to break the link between investment and  $q$ , requires the presence of both short-lived shocks – which tend to move investment more and have relatively smaller effects on  $q$  – and long-lived shocks – which do the opposite.

These points are developed in the context of a stochastic model of investment subject to limited enforcement, with fully state-contingent claims. The ability of borrowers to issue state-contingent claims is limited by the fact that, ex post, they can renege on their promises and default. The consequence of default is the loss of a fraction of invested assets. We show that this environment is equivalent to an environment with state-contingent collateral constraints, so the model is essentially a stochastic version of Kiyotaki and Moore (1997) with adjustment costs and state-contingent claims. The model leads to a wedge between average  $q$  – which correspond to the  $q$  measured from financial market values – and marginal  $q$  – which captures the marginal incentive to invest and is related one-to-one to investment.

We then study the implications of the model for investment regressions in which the investment rate is regressed on average  $q$  and cash flow. In this we follow a large empirical literature since Fazzari et al. (1988) and Gilchrist and Himmelberg (1995), although in our case the regressions are run on simulated output from the model.

The model is calibrated to data moments from Compustat, i.e. for firm listed on the U.S. stock market. The calibration is based on a two shocks structure, with temporary and persistent shocks.  $q$  responds relatively more strongly to the persistent shock while investment responds relatively more strongly to the transitory shock. This leads to investment regressions with a smaller coefficient on  $q$  and a larger coefficient on cash flow, relative to a model with no financial frictions, thus bringing us closer to empirical coefficients. However, the  $q$  coefficient is still larger than in the data and the cash flow coefficient is smaller than in the data. When adding the possibility of news shocks, the disconnect between  $q$  and investment increases, leading to further reductions in the  $q$  coefficient and increases in the cash flow coefficient.

## Literature cited

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Gilchrist, S. and Himmelberg, C. P., 1995, "Evidence on the role of cash flow for investment", *Journal of Monetary Economics*, Vol. 36(3), pp. 541–572.

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## Research projects pursued in 2018

### CREDIT AND BANKING

#### Curbing Shocks to Corporate Liquidity: The Role of Trade Credit

*Niklas Amberg, Tor Jacobson, Robert Townsend and Erik von Schedvin*

Using data on exogenous liquidity shortfalls generated by the fraud and failure of a cash-in-transit firm, we demonstrate a causal effect on firms' trade credit usage. We find that firms manage liquidity shortages by increasing the amount of drawn credit from suppliers and decreasing the amount issued to customers. The compounded trade credit adjustments are of a similar size as corresponding adjustments in cash holdings, suggesting that trade credit positions are economically important sources of reserve liquidity for firms. The underlying mechanism in trade credit adjustments is in part due to shifts in credit durations.

(Continuing from previous year)

#### Inter-Firm Lending: An Empirical Analysis of Trade Credit Contracts

*Niklas Amberg, 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)

#### The Role of Trust in Online Lending

*Christoph Bertsch, Isaiah Hull, Yingjie Qi and Xin Zhang*

We study the impact of trust on the expansion of online lending in the U.S. over the 2008-2016 period. Using nearly complete loan and application data from the online lending market, we demonstrate that a misconduct-driven decline of trust in traditional banking is associated with a statistically and economically significant increase in online lending at the state level. To the contrary, increased social trust strengthens in-person, bank-based borrowing and informal borrowing, reducing the demand for impersonal online lending. Both of these effects operate primarily through borrowers. We also use a shock that affects only investors to demonstrate that distrust in traditional finance increases participation in online lending.

(Continuing from previous year)

#### Trade Credit and Pricing: An Empirical Evaluation

*Niklas Amberg, Tor Jacobson, and Erik von Schedvin*

We empirically investigate the proposition that firms charge premia on cash prices in transactions involving trade credit. Using a comprehensive Swedish panel dataset on product-level transaction prices and firm-characteristics, we relate trade credit issuance to price setting. In a recession characterized by tightened credit conditions, we find that prices increase significantly more on products sold by firms issuing more trade credit, in response to higher opportunity costs of liquidity and counterparty risks. Our results thus demonstrate the importance of trade credit for price setting and show that trade credit issuance induces a channel through which financial frictions affect prices.

(Continuing from previous year)

## **ECONOMETRICS**

### **Risk Endogeneity at the Lender-/Investor-of-Last-Resort**

*Diego Caballero, André Lucas, Bernd Schwaab and Xin Zhang*

The riskiness of a central bank's balance sheet depends on the financial health of its counterparties, which in turn depends on the central bank's liquidity provision and asset purchases, particularly during a liquidity crisis. We propose a novel framework to study the time-variation in central bank portfolio credit risks associated with monetary policy operations. The framework accommodates numerous bank and sovereign counterparties, fat tails, skewness, and time-varying dependence parameters. In an application to items from the European Central Bank's weekly balance sheet between 2009 and 2015, we find that unconventional monetary policy operations tended to generate beneficial risk spill-overs across monetary policy operations. Some were 'self-financing' in risk terms.

(Continuing from previous year)

### **Score-Driven Tail Shape, with Application to Bond Yields at a High Frequency**

*André Lucas, Bernd Schwaab and Xin Zhang*

We propose an observation-driven modeling framework for estimating time series variation in the tail shape parameter of a Generalized Pareto Distribution. We discuss different ways of handling non-tail observations and relate tail shape variation to observed covariates. We then use the model to study the yield, volatility, and tail shape impact of bond purchases by the European Central Bank between 2010--2012. Bond purchases lowered the conditional mean of bond yields by about -0.2 to -3.5 bps per 1 billion of purchases. The announcement of the program had a significant impact on the tail shape.

(Continuing from previous year)

## **FINANCIAL MARKETS**

### **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)

### **Pricing Default Exposure to Downside Risks**

*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.

(Continuing from previous year)

## FINANCIAL THEORY

### A Wake-Up Call Theory of Contagion

*Toni Ahnert and Christoph Bertsch*

We offer a theory of contagion based on the information choice of investors after observing a financial crisis elsewhere. We study global coordination games of regime change in two regions with an unobserved common macro shock as the only link between regions. A crisis in the first region is a wake-up call to investors in the second region. It induces them to reassess the regional fundamental and acquire information about the macro shock. Contagion can even occur after investors learn that regions are unrelated (zero macro shock). Our results rationalize empirical evidence about contagious bank runs and currency crises after wake-up calls. We also derive new implications and discuss how these can be tested.

(Continuing from previous year)

### Optimal Bank Capitalization in Crowded Markets

*Christoph Bertsch and Mike Mariathasan*

We study banks' optimal equity buffer in general equilibrium and their response to under-capitalization. Making progress towards a "pecking order theory" for private recapitalizations, our benchmark model identifies equity issuance as individually and socially optimal, compared to deleveraging, as well as conditions that invert the individually optimal ranking. Imperfectly elastic supply of capital, incomplete insurance markets and costly bankruptcies give rise to inefficiently high leverage ex-ante, and to excessive capital shortfalls and insolvencies ex-post. Abstracting from moral hazard and informational asymmetries, we therefore provide a novel rationale for macroprudential capital regulation and new testable implications about banks' capital structure management.

(Continuing from previous year)

## GROWTH

### Fuel for Economic Growth

*Johan Gars and Conny Olovsson*

Using data on energy inputs for 134 countries, we document that countries that derive a larger share of their energy from fossil energy sources are richer and grow faster. We then set up an endogenous growth model in which the efficiency of both capital and fossil energy can be improved, whereas that of an 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 source, and one with balanced growth where energy is fully sourced from fossil fuel. Heterogeneity in initial technology 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)

## HOUSEHOLD FINANCE AND HOUSE PRICES

### Do Robots Increase Wealth Dispersion?

*Thomas Jansson and Yigitcan Karabulut*

We demonstrate that increased automation has a significant impact on both static and dynamic aspects of wealth distribution. Households who are more exposed to robots at work accumulate less wealth and experience greater downward mobility in the wealth distribution. The negative wealth effects of robots are not merely a consequence of differences in earned incomes or in saving rates. We argue and provide evidence that the adverse effects of rapid robotization on individual workers' human capital, and thereby, on their financial risk taking behavior and investment choices appear to be an additional operative channel.

(New)

### Financial Literacy Externalities

*Michael Haliassos, Thomas Jansson and Yigitcan Karabulut*

This paper uses unique administrative data and a quasi-field experiment of exogenous allocation in Sweden to estimate medium- and longer-run effects on financial behavior from exposure to financially literate neighbors. It contributes evidence of causal impact of exposure and of a social multiplier of financial knowledge, but also of unfavorable distributional aspects of externalities. Exposure promotes saving in private retirement accounts and stockholding, especially when neighbors have economics or business education, but



only for educated households and when interaction possibilities are substantial. Findings point to transfer of knowledge rather than mere imitation or effects through labor, education, or mobility channels.  
(Continuing from previous year)

## House Prices, Home Equity, and Personal Debt Composition

*Jieying Li and Xin Zhang*

Using a monthly panel dataset of Swedish individuals' debt composition including mortgage and non-mortgage consumer credit, we show that house price changes can explain a significant fraction of personal debt composition dynamics. We exploit the variation in local house price growth as shocks to homeowners' housing wealth to study the consequential adjustment of personal debt composition. To account for local demand shocks and disentangle the housing collateral channel from the wealth effect, we use renters and non-equity-withdrawal homeowners in the same region as control groups. We present direct evidence that homeowners reoptimize their debt structure by using withdrawn home equity to pay down comparatively expensive short-term non-mortgage debt during a housing boom, unsecured consumer loans in particular. We also find that homeowners withdraw home equity to finance their entrepreneurial activities. Our study sheds new light on the dynamics of personal debt composition in response to changes in house prices.

(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)

## Manufacturing Decline and House Price Volatility

*Isaiah Hull, Conny Olovsson, Karl Walentin, Andreas Westermark*

**Abstract:** Using a unique dataset of all Swedish housing transactions over the 2009-2017 period, we find that an increase in manufacturing's share of employment is positively associated with house price growth volatility and negatively associated with risk-adjusted housing returns. Both effects appear to be related to manufacturing's impact on firm concentration, employment growth volatility, and economic uncertainty. Moreover, as we demonstrate in an application, our results have implications for portfolio choice. They also suggest that the manufacturing decline since 1970 could account for a 32% reduction in house price volatility in Sweden, and similar reductions in the U.S., U.K., and Japan.

(New)

## Monetary and Macro Prudential Policies in a Low Interest-Rate Environment

*Jack Chen, Daria Finocchiaro, Jesper Lindé and Karl Walentin*

Household indebtedness and real housing prices have risen to unprecedented levels in many advanced economies amid the persistent decline in real interest rates. In order to stem household indebtedness and household vulnerability to higher interest rates, policymakers have deployed macroprudential policy (MPP) tools and in many countries there are calls for further actions. In this paper, we examine the short- and long-term effects of different MPP tools. The analysis is conducted in the Iacoviello and Neri (2010) two-agent New Keynesian model augmented to include long-term debt, housing transaction costs and a zero lower bound constraint on policy rates. We find that the long-term costs of both the MPP tools we consider are very moderate. Even so, the short-term effects depend critically on the initial debt level and the scope for the central bank to provide accommodation. When monetary policy is unconstrained and the initial debt level is low, it will be notably easier for monetary policy to accommodate the policy actions and the short-term costs will be small. But in an environment with elevated debt levels and little scope for the central bank to cut its policy rate, large macroprudential actions may be associated with significant contractionary pressures. To sum-up, our findings stress the importance of taking the interactions between monetary policy and actions to stem

household indebtedness into careful account when designing macroprudential policies aimed at addressing current debt imbalances.

(New)

## The Impact of Social Environment on Entrepreneurial Risk and Its Distributional Effects

*Michael Haliassos, Thomas Jansson and Yigitcan Karabulut*

Using a rare natural experiment regarding the exogenous spatial allocation of refugee immigrants in Sweden, we focus on the role of social environment in the entrepreneurial process. We analyze whether early interactions with entrepreneurs have any causal effects on the decision to start a new business, and conditional on being a business owner, on the entrepreneurial income. We find they do. Interestingly, only exposure to successful entrepreneurs has a significant effect, while exposure to unsuccessful entrepreneurs displays no effect on the subsequent entrepreneurial activity. We further analyze the potential mechanisms and find strong suggestive evidence that conforms to transfer of tacit knowledge as the operative channel. Finally, we show that the increased exposure to idiosyncratic entrepreneurial risk leads to a higher rank in the wealth distribution.

(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)

### Endogenous Separations, Wage Rigidities and Employment Volatility

*Mikael Carlsson and Andreas Westermark*

We show that in micro data, as well as in a search and matching model with endogenous separations and rigid wages, separations and hence employment volatility are non-neutral to wage rigidities of incumbent workers. In contrast to when all wages are flexible, the standard deviation of unemployment in a model with rigid wages for incumbent workers (only) matches the standard deviation in the data. Thus, the degree of wage rigidity for newly hired workers is not a sufficient statistic for determining the effect of wage rigidities on macroeconomic outcomes in this class of models.

(Continuing from previous year)

### Learning on the Job and the Cost of Business Cycles

*Karl Walentin and Andreas Westermark*

We show that business cycles reduce welfare through a decrease in the average level of employment in a labor market search model with learning on-the-job and skill loss during unemployment. A negative correlation between unemployment and vacancies implies, via the concavity of the matching function, that business cycles reduce the average number of new jobs and employment. Learning on-the-job implies that the decrease in employment reduces aggregate human capital. This, in turn, reduces the incentives to post vacancies, further decreasing employment and human capital. We quantify this mechanism and find large output and welfare costs of business cycles.

(Continuing from previous year)

### Skill Loss, Job Mismatch and the Slow Recovery from the Great Recession

*Karl Walentin and Andreas Westermark*

In this paper we ask to what degree i) human capital dynamics induced by skill loss during unemployment and ii) job mismatch (low match quality) contributed to the slow recovery from the Great Recession, in particular the low post-2009 growth in GDP, labor productivity and real wages. Mismatch has increased because workers that lost their jobs in the recession tend to be less well matched compared to their pre-recession jobs. We find that the increase in unemployment during the initial phase of the Great Recession had long-lasting effects through the skill loss it induced, mainly in terms of increased unemployment and reduced GDP.

(New)

## MACROECONOMICS

### A Framework for the Choice of Capital for a Central Bank in a Small Open Economy

*David Vestin*

The paper proposes a framework for balance-sheet analysis, in particular concerning how much capital a central bank needs to hold. The idea is to formulate a risk-mandate for the central bank in terms of the probability of the need for recapitalization during the next 20 years. A Bayesian VAR-model is then employed to describe the joint evolution of interest rates, inflation, the exchange-rate and gold prices. We then show how various proposals for adjustments to the balance-sheet, driven by policy needs, may need to be accompanied with adjustments in the amount of capital that the bank needs to hold.

(New)

### Energy-Saving Technical Change

*John Hassler, Per Krusell, and Conny Olovsson*

How do markets economize on scarce natural resources? In this paper we emphasize technological change aimed at saving on the scarce resource. We develop a neoclassical macroeconomic theory that is quantitatively oriented and that views technical change as directed: it can be used to save on different inputs. At a point in time, the elasticity between inputs - in our application a capital-labor composite and fossil energy - is given by a production function with fixed parameters, but because the future values of these parameters can be changed with R&D efforts today, the long-run elasticity between the inputs is higher than it is in the short run. We demonstrate how the theory can be used to robustly derive predictions for the long-run cost share accruing to the scarce resource as well as for its rate of depletion. In an application, we look at postwar U.S. data, estimate the short-run elasticity between inputs using an aggregate CES production function, and also estimate the implied input-saving technology series. From these technology series, we can gauge what the historical tradeoff has been in the choice between allocating R&D to save on one or the other input. The implied parameter estimates are then used in our aggregate model to make long-run predictions, which indicate a marked increase in the share of costs going to fossil energy.

(Continuing from previous year)

### Estimation of Operational Macromodels at the Zero Lower Bound

*Jesper Lindé, Junior Maih, and Rafael Wouters*

We present and apply estimation techniques which can be used to estimate large-scale macromodels with forward-looking expectations at the zero lower bound (ZLB). Using the workhorse models of Smets and Wouters (2007) and the Galí, Smets and Wouters (2011) models, we compare the merits of estimation methods in which the expected duration of the ZLB incident is modelled as endogenous and derived from the policy rule forecast with Regime-Switching methods for which the expected ZLB duration is constant. Using the estimated models, we discuss the extent to which imposing the ZLB impacts filtered shocks, impulse response functions, and forecasts during the crisis. Finally, we use the estimated models and shocks to assess the aggregate costs of the ZLB incidence in the United States.

(New)

### Integrated Assessment in a Multi-region World with Multiple Energy Sources and Endogenous Technical Change

*John Hassler, Per Krusell, and Conny Olovsson*

We construct an integrated assessment model with multiple imperfectly substitutable energy sources---including fossil fuels and "green energy"---and multiple world regions. The model also incorporates fracking and endogenous technical change directed at reducing the production costs for the different energy sources. Apart from the oil price, all endogenous variables have closed-form solutions. We derive four main results. First, if only Europe were to implement optimal taxes, this would have negligible effects on reducing global warming. Second, an effective carbon tax must be levied also on oil that is produced with fracking technology.



Third, a coal tax that is proportional to the coal price is completely impotent. Fourth, per-unit taxes are effective in mitigating global warming. In this case, endogenous technical change reinforces the effectiveness of carbon taxes.

(Continuing from previous year)

## International Business Cycles: Quantifying the Effects of a World Market for Oil

*Johan Gars and Conny Olovsson*

To what extent is the international business cycle affected by the fact that an essential input (oil) is traded on the world market? We quantify the contribution of oil by setting up a model with separate shocks to efficiencies of capital/labor and oil, and global shocks to the oil supply. The oil related shocks both contribute to comovements in output and inputs. The wealth effect associated with these shocks is typically smaller than the substitution effect, which induces higher responses in output than in consumption. Overall, the model can resolve both the consumption correlation puzzle and the international comovement puzzle.

(Continuing from previous year)

## Measuring U.S. Time Series Volatility During the Great Moderation

*Isaiah Hull*

**Abstract:** We identify volatility breaks in all testable series in the FRED database over the 1957-2013 period. This yields 17,681 breaks, which we categorize using text analysis. We show that 70.5% of series categories experienced a decline in volatility over the 1985-1999 period, suggesting that the Great Moderation was far broader in scope than the literature has documented. We also show that this decline reversed in 2000, leading to a sharp increase in volatility for most time series categories; however, this did not fully materialize in GDP volatility until the Great Recession. Finally, we identify labor markets, demographics, finance, and government debt as potential drivers of low-frequency shifts in volatility over the 1957-2013 period.

(Continuing from previous year)

## Resolving the Missing Deflation Puzzle

*Jesper Lindé and Mathias Trabandt*

We propose a resolution of the missing deflation puzzle, i.e. the fact that inflation fell very little during the Great Recession against the backdrop of the large and persistent fall in GDP. Our resolution of the puzzle stresses the importance of nonlinearities in price and wage-setting using Kimball (1995) aggregation. We show that a nonlinear macroeconomic model with Kimball aggregation resolves the missing deflation puzzle, while a linearized version of the same underlying nonlinear model fails to resolve the missing deflation puzzle. In addition, our nonlinear model reproduces the skewness of inflation and other macroeconomic variables observed in post-war U.S. data. All told, our results caution against the common practice of using linearized models to study inflation-output dynamics when the economy is exposed to large shocks.

(New)

## The Impact of Foreign Shocks on the Swedish Economy

*Jesper Lindé, Conny Olovsson, and Spyridon Sichlirimis*

We aim to explain the positive cross-country comovement observed in the data among the main macroeconomic variables both nominal and real ones. We address the comovement problem by introducing international trade in durables. Durables trade in OECD represents roughly 2/3 of the total imports and the total exports. Based on the work of Engel & Wang (2011), incorporating durables trade into a standard international business cycle model improves substantially the volatility of imports and exports and induces positive correlation of these variables with respect to GDP. However, the issue of comovement has not been addressed because prices are flexible. We intend to build a two country New-Keynesian model with price and wage stickiness. Given the price stickiness, there has to be a strong adjustment through quantities that can potentially induce positive comovement among the main macroeconomic variables across the two countries.

(Continuing from previous year)

## MONETARY POLICY AND THEORY

### Gains from Wage Flexibility and the Zero Lower Bound

*Roberto Billi and Jordi Galí*

We analyse the welfare impact of greater wage flexibility while taking into account explicitly the existence of the zero lower bound (ZLB) constraint on the nominal interest rate. We show that the ZLB constraint generally amplifies the adverse effects of greater wage flexibility on welfare when the central bank follows a conventional

Taylor rule. When demand shocks are the driving force, the presence of the ZLB implies that an increase in wage flexibility reduces welfare even under the optimal monetary policy with commitment.  
(Continuing from previous year)

## Liquidity, Capital Pledgeability and Inflation Redistribution

*Paola Boel, Daria Finocchiaro, Julian P. Diaz*

We develop a microfounded model of money with capital where households discount the future at different rates and are subject to trading risk. Capital can be pledged as collateral and is less liquid than money. We assess the redistributive effects of expected inflation between borrowers and lender in such an environment.  
(New)

## Monetary Normalizations and Consumer Credit: Evidence from Fed Liftoff and Online Lending

*Christoph Bertsch, Isaiah Hull and Xin Zhang*

On December 16th of 2015, the Fed initiated "liftoff," a critical step in the monetary normalization process. We use a unique panel dataset of 640,000 loan-hour observations to measure the impact of liftoff on interest rates, demand, and supply in the online primary market for uncollateralized consumer credit. We find that credit supply increased, reducing the spread by 16% and lowering the average interest rate by 16.9-22.6 basis points. Our findings are consistent with an investor-perceived reduction in default probabilities; and suggest that liftoff provided a strong, positive signal about the future solvency of borrowers.  
(Continuing from previous year)

## Monetary Policy Under Disagreement

*David Vestin and Oreste Tristani*

We construct a model that can account for the observed discrepancies between market-based interest rate forecasts and the forecast of the Riksbank. We examine the economic implications of such discrepancies and the implications for the monetary policy stance. We discuss possible implications for the conduct of optimal monetary policy.  
(Continuing from previous year)

## Money, Credit and Banking and the Cost of Financial Activity

*Paola Boel and Gabriele Camera*

We investigate the effects of banks' operating costs on allocations and welfare in a low interest rate environment. We introduce an explicit production function for banks in a microfounded model where banks employ labor resources, hired on a competitive market, to run their operations. In equilibrium, this generates a spread between interest rates on loans and deposits, which naturally reflects the underlying monetary policy and the efficiency of financial intermediation. In a deflation or very low inflation environment, equilibrium deposits yield zero returns. Hence, banks end up soaking up labor resources to offer deposits that do not outperform idle balances, thus reducing aggregate efficiency.  
(Continuing from previous year)

## Output Gaps and Robust Monetary Policy Rules

*Roberto Billi*

Policymakers often use the output gap to guide monetary policy, even though inflation and nominal gross domestic product (GDP) are measured in real time more accurately than the output gap. Employing a small New Keynesian model with a zero lower bound (ZLB) on nominal interest rates, this article compares the performance of monetary policy rules that are robust to persistent errors in the measurement of economic conditions. It shows that, in the absence of the ZLB, the central bank should focus on stabilizing inflation rather than nominal GDP. But present the ZLB, a policy that seeks to stabilize the level of nominal GDP improves substantially the trade-offs faced by the central bank.  
(Continuing from previous year)

## Renovatio Monetae: When Gesell Taxes Worked

*Roger Svensson and Andreas Westermark*

Gesell taxes on money have recently received attention as a way of alleviating the zero lower bound on interest rates. Less known is that such taxes were an important method for generating seigniorage in medieval Europe for around two centuries. When a Gesell tax was levied, current coins ceased to be legal and had to

be exchanged into new coins for a fee. This could occur as often as twice a year. Using a cash-in-advance model, we analyze under what conditions agents exchange coins and the tax generates revenues. A key result is that the system broke down because of increases in fiscal spending, and not because non-cash alternatives, e.g., bartering, became more costly. We also analyze how prices fluctuated over an issue period. (Continuing from previous year)

## Spread the Word: International Spillovers from Central Bank Communication

*Hanna Armelius, Christoph Bertsch, Isaiah Hull and Xin Zhang*

We use text analysis and a novel dataset to measure the sentiment component of central bank communications in 23 countries over the 2002-2017 period. Our analysis yields three key results. First, using directed networks, we show that comovement in sentiment across central banks is not reducible to trade or financial flow exposure. Second, we find that geographic distance is a robust and economically significant determinant of comovement in central bank sentiment, while shared language and colonial ties are economically significant, but less robust. Third, we use structural VARs to show that sentiment shocks generate cross-country spillovers in sentiment, policy rates, and macroeconomic variables. We also find that the Fed plays a uniquely influential role in generating such sentiment spillovers, while the ECB is primarily influenced by other central banks. Overall, our results suggest that central bank communication contains systematic biases that could lead to suboptimal policy outcomes.

(New)

## Stabilization Policy at the Zero Lower Bound

*Paola Boel and Christopher J. Waller*

We construct a monetary economy in which agents face aggregate liquidity shocks and heterogeneous idiosyncratic preference shocks. We show that, in this environment, not all agents are satiated at the zero lower bound even when the Friedman rule is the best interest-rate policy the central bank can implement. As a consequence, there is scope for central bank stabilization policy, which takes the form of repo arrangements in response to aggregate demand shocks. We find such a policy temporarily relaxes the liquidity constraint of impatient agents without harming the patient ones, thus improving welfare even at the zero lower bound. Due to a pecuniary externality, the policy may also have beneficial general-equilibrium effects for the patient agents even if they are unconstrained in their holdings of real balances.

(Continuing from previous year)

## The Long-Run Forward Guidance Puzzle

*David Vestin*

The paper identifies a long-run forward-guidance puzzle in the standard NK-model, in that pre-announced monetary policy gives real effects reaching very far into the future, and shows that standard solutions to the forward-guidance puzzle do not rectify this issue. The paper goes on to show that changing the pricing-assumption from Calvo to Mankiw-Reis solves the long-run puzzle, and combining it with discounting in the Euler equation yields a fully satisfactory solution to both puzzles.

(Continuing from previous year)

## Publications accepted in 2018

Adolfson, Malin, Stefan Laséen, and Jesper Lindé, "Identification Versus Misspecification in New Keynesian Monetary Policy Models", forthcoming in *European Economic Review*.

Boel, Paola, 2018, "The Redistributive Effects of Inflation and the Shape of Money Demand", *Journal of Economic Dynamics and Control*, Vol. 90, 208–219.

Cao, Dan, Guido Lorenzoni, and Karl Walentin, "Financial Frictions, Investment and Tobin's  $q$ ", forthcoming in *Journal of Monetary Economics*.

Debortoli, Davide, Jinill Kim, Jesper Lindé, and Ricardo Nunes, "Designing a Simple Loss Function for Central Banks: Does a Dual Mandate Make Sense?", forthcoming in *Economic Journal*.

Finocchiaro, Daria, Giovanni Lombardo, Caterina Mendicino, and Philippe Weil, 2018, "Optimal Inflation with Corporate Taxation and Financial Constraints", *Journal of Monetary Economics*, Vol. 95, 18–31.

Hassler, John, Per Krusell, and Conny Olovsson, "The Consequences of Uncertainty: Climate Sensitivity and Economic Sensitivity to the Climate", forthcoming in *Annual Review of Economics*.

Lindé, Jesper, Andrea Pescatori, "The Macroeconomic Effects of Trade Tariffs: Revisiting the Lerner Symmetry Result", forthcoming in *Journal of International Money and Finance*.

Olovsson, Conny, "Oil prices in a real-business-cycle model with precautionary demand for oil," forthcoming in *Review of Economic Dynamics*.

## Working papers

No. 360, Paola Di Casola and Spyridon Sichlimiris, "Towards Technology-News-Driven Business Cycles".

No. 359, Mats Levander, "Diversification Advantages During the Global Financial Crisis".

No. 358, Anna Grodecka, Seán Kenny and Anders Ögren, "Predictors of Bank Distress".

No. 357, Hanna Armelius, Christoph Bertsch, Isaiah Hull and Xin Zhang, "Spread the Word: International Spillovers from Central Bank Communication".

No. 356, Sebastian Franco and Erik Frohm, "Reduced "Border Effects", FTAs and International Trade".

No. 355, Rafael De Rezende and Annukka Ristiniemi, "A Shadow Rate Without a Lower Bound Constraint".

No. 354, Niklas Amberg, Tor Jacobson, and Erik von Schedvin, "Trade Credit and Pricing: An Empirical Evaluation".

No. 353, Karl Walentin and Andreas Westermark, "Learning on the Job and the Cost of Business Cycles".

No. 352, Vesna Corbo and Paola Di Casola, "Conditional Exchange Rate Pass-Through: Evidence from Sweden".

No. 351, Maria Sandström, "The Impact of Monetary Policy on Household Borrowing – a High-Frequency IV Identification".

## Non-refereed publications in 2018

### Sveriges Riksbank and the History of Central Banking

*Edited by Rodney Edvinsson, Tor Jacobson, and Daniel Waldenström*  
Cambridge University Press

Written in celebration of its 350th anniversary in 2018, this book details the history of the central bank of Sweden, Sveriges Riksbank, as presented by Klas Fregert. It relates the bank's history to the development of other major central banks around the world. Chapters are written by some of the more prominent scholars in the field of monetary economics and economic history. These chapters include an analysis of the Bank of England written by Charles Goodhart; the evolution of banking in America, written by Barry Eichengreen; a first account of the People's Bank of China, written by Franklin Allen, Xian Gu, and Jun Qian; as well as a chapter about the brief but important history of the European Central Bank, written by Otmar Issing.

### Financial Frictions, Financial Regulation and their Impact on the Macroeconomy

*Daria Finocchiaro and Anna Grodecka*  
Sveriges Riksbank Economic Review

In the aftermath of the global financial crisis, increasing attention has been paid to the role played by financial factors in business cycle fluctuations. The crisis also led to the development of economic policies, beyond traditional microprudential regulation, that promote financial stability. Macroprudential policy is one such tool. It fosters a more resilient financial system by directly tackling systemic risk, that is the risk of a breakdown of the entire financial system with significant economic costs. Yet macroprudential policy is still in its 'infancy'. In this article, we first emphasize the importance of financial markets for our understanding of the real economy and how they have traditionally been incorporated in macroeconomic models. Then we discuss the rationale for macroprudential regulation and present a cost-benefit framework to evaluate the merits of different

macroprudential instruments; the benefits include a more resilient financial system and stable economy, and the costs involve forgone lending and lower economic activity. We conclude by summarizing some of the remaining challenges in the field.

## Is Climate Change Relevant for Central Banks?

*Conny Olovsson*

Economic Commentaries

Global warming and its consequences are relevant for central banks as these consequences may conceivably have an impact on both financial stability and monetary policy. Central banks should therefore prepare themselves by investing resources in the analysis of the possible effects of climate change on the real economy, as well as the implications for monetary policy and financial stability. However, monetary policy does not have the appropriate tools for counteracting global warming, but global fiscal policy is significantly better suited for this purpose.

## Comment on Johan Lönnroth's Economic Debate article "Letter to the Riksbank parliamentary committee"

*Jesper Lindé and André Reslow*

Ekonomisk Debatt

## Other research activities

### Conferences

Daria Finocchiaro and Karl Walentin, in collaboration with the IIES, St. Louis Federal Reserve, and Ragnar Söderbergs Stiftelse hosted a conference on theoretical and empirical research regarding "Housing, Credit and Heterogeneity: New Challenges for Stabilization Policies" on 13-14 September, 2018. The recent global financial crisis and subsequent anemic recovery in the Euro area and United States has brought to light the importance of housing and credit markets for the macroeconomy. The crisis also revealed apparently important shortcomings of the prevailing paradigm at the heart of business cycle macroeconomics, the representative agent model. New macroeconomic models featuring inequality and aggregate uncertainty, as well as a wealth of new microeconomic data, have opened up exciting new avenues for research. The aim of the conference was to bring together researchers focusing on heterogeneity in households and firms and the interplay of that heterogeneity with macroeconomic policy and aggregate fluctuations. The keynote speakers were Christopher Carroll and Sydney Ludvigson.

### Greater Stockholm Macro Group

Together with Per Krusell (IIES, Stockholm University), the Research Division continued 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.

### Internship Program

As customary, the Research Division hosted four PhD interns in 2016. This year's interns were Pablo Anaya Longaric (Freie Universität Berlin), Hendro Sugandi (Stockholm School of Economics), Karin Kinnerud (Institute for International Economic Studies), and Markus Peters (Institute for International Economic Studies)

### Research Seminars

The Research Division organizes weekly research seminars, mainly by invited international speakers. The seminars usually take place on Tuesdays at 1 pm and attendance is open to Riksbank employees as well as to academics. A complete list of both upcoming and past seminars is available on the homepage of the Riksbank's Research Division: [www.riksbank.se/en/The-Riksbank/Research/Seminars/](http://www.riksbank.se/en/The-Riksbank/Research/Seminars/)

### Sabbaticals

Roberto Billi is working at the European Central Bank in DG Research, ESCB/IO, from 2 July 2018 to 31 December 2018.

Daria Finocchiaro is working 70% at Uppsala University, from September 2018. At Uppsala University, Daria is teaching parts of two courses: Macroeconomic Theory I (PhD) and Applied Macro (Master program), and provides undergraduate thesis supervision.



Tor Jacobson was on a sabbatical visit to the Reserve Bank of Australia from November 1, 2017 to March 31, 2018.

Erik von Schedvin was on a sabbatical visit to the Federal Reserve Bank of San Francisco from November 1, 2017 to March 31, 2018.

### **Teaching and Advising**

Conny Olovsson taught, together with John Hassler and Per Krusell, the course “The Climate and the Economy” during the spring of 2018 at Stockholm University. The course explains how economic tools can be used to analyze environmental issues and, in particular, climate change: its causes and effects and the role for economic policy in influencing our future. The focus is on economic methods in theory and practice but the course also covers the basic aspects of the natural sciences involved.

Jesper Lindé taught guest lectures at Stockholm School of Economics and Uppsala University, acted as a co-advisor for André Reslow at Uppsala University, and advised two master students at the Stockholm School of Economics.

Isaiah Hull taught a lecture titled “Scraping, Text Analysis, and Data Visualization in Python” at the Riksbank for visiting data science students on scraping, text analysis, and data visualization in Python. Isaiah also provided guest lectures for the course “Global Solution Methods” at Stockholm School of Economics. The guest lectures covered backwards recursion, value function iteration, policy function iteration, and project methods.

Andreas Westermark taught parts of a second year PhD course in monetary economics. The course is taught at the Riksbank and Stockholm University, with the purpose of introducing students to modern New Keynesian models for monetary policy and business cycle analysis.

### **Miscellanea**

Thomas Jansson participated at the ECB Household Finance and Consumption Network (HFCN) meetings.

## **Upcoming events in 2019**

On May 17th–18th 2019, Karl Walentin and Andreas Westermark, together with Kiel Institute for the World Economy will be organizing a workshop on “New Developments in the Macroeconomics of Labor Markets”. The workshop will take place at the Riksbank and features Philipp Kircher and Per Krusell as keynote speakers.

On September 13th–14th 2019, Sveriges Riksbank in cooperation with the Bank of Canada, Norges Bank, Reserve Bank of Australia, and Reserve Bank of New Zealand, is organizing a conference to discuss new theoretical and empirical research on the determinants of business cycles in small open economies and implications for policy. The keynote speakers will be Jordi Galí (UPF, CREI, and CEPR) and Giancarlo Corsetti (University of Cambridge and CEPR).

On November 7th–8th 2019, Sveriges Riksbank division will host the “15th Central Bank Workshop on the Microstructure of Financial Markets”. The keynote speaker will be Ingrid Werner (Ohio State University).

In the spring, a second year PhD course on monetary economics will be given at the bank. The course is taught by faculty from Stockholm University and the Riksbank. The purpose of the course is to introduce students to modern New Keynesian models for monetary policy and business cycle analysis. These models are dynamic stochastic general equilibrium models based on optimizing behaviour and rational expectations. At the same time, they incorporate price and wage rigidity, permitting an important role for aggregate demand shocks and monetary policy to affect activity. They have become a standard tool for central banks and they are used as a framework for much modern research in macroeconomics. The course will cover the basic New Keynesian model, optimal policy, labor market frictions, open economy, and also introduce methods for solution and simulation. Throughout, we will emphasize the microeconomic foundations of these models. We hope that, after finishing this course, participants will feel comfortable working with these models.

## Interview with Charles Goodhart (continuing from page 2)

Now, approaching the end of this 350 years jubilee year, it is of course natural to start thinking about what the coming 350 years might entail for the Riksbank, and for central banks in general. We therefore turn to Charles Goodhart for this year's Research News interview; who else would be in a better position to judge the future of central banking? Charles has spent his career thinking hard about monetary economics and its policy implications, and about financial regulation, with his feet firmly planted both in the academic community but equally much in the policy world. He has, according to his own words, written more books and articles on these subjects throughout the last 50 or 60 years than any sane person would want to read, suggesting a wealth of wisdom to draw from (our words).

*Q1. At the Riksbank there is currently a lot of interest in the creation of an E-krona, i.e., a central bank digital currency. We are seriously evaluating the pros and cons of complementing the regular currency with an electronic version. Similar initiatives can be seen in other central banks. Are these the first steps towards the future?*

It is, I believe, highly likely that the Riksbank will soon be making E-Krona, digital currency, available to all residents. It will be one of the first Central Banks to do this, though there are some others, e.g. the Monetary Authority of Singapore, who are also considering this step. But Sweden is an outlier in this field in several ways. First, unlike almost every other major country, the ratio of cash holdings to GDP has been going down quite sharply. The Swedish population has embraced digital payment mechanisms with a greater enthusiasm than almost anywhere else. Physical currency, particularly large value notes, are widely held and used to make and receive payments in the grey and black economies, e.g. if you pay in cash, the recipient can more easily avoid VAT. Swedes form an unusually law-abiding community. With cash usage declining sharply, handling, transporting and safeguarding cash has become a relatively more expensive chore, especially for bank branches in the sparsely-populated northern regions of Sweden. So, substituting E-Krona for paper-Krona would save costs for the commercial banks. In other countries, central bank issue of digital currency might appear as the thin-end of the wedge for central banks to start once again competing with commercial banks, but in Sweden the cost-saving may well make the commercial banks welcome this move.

So, Sweden is likely to be among the first to take this step, and other central banks will be watching this experiment closely. There are a number of concerns. First, should concerns ever arise again about commercial bank solvency, would the availability of such digital currency make the switch out of commercial bank deposits into central bank money easier, more immediate and larger scale for residents? They always had the option of shifting into currency. Again, if the switch from physical currency to digital currency becomes almost universal, what would happen in the case of tourists, recent immigrants, and other non-residents without access to digital currency? Then again, the holding of digital currency is centralized in the central bank's electronic system, whereas physical currency is widely distributed. Would that make the whole system more susceptible to cyber attack, electricity failure, or anything else that could disrupt the central bank itself?

So, Sweden will probably take this step, but I expect most other major countries will wait to see how Sweden's experiment works before moving in the same direction, if they do so at all.

*Q2. Another topic, which is always a concern nowadays in central banks is financial regulation; where is that likely to head in the future? A decade or so after the global financial crises, the capital adequacy framework is being geared towards including elements of forward looking assessments of risks in banks' assets, as well the introduction of backstops in form of minimal capital and liquidity positions to foster bank resilience. Is this development likely to continue?*

A common aphorism is that known risks should be covered by the margin, or risk premium, obtained by banks in making that loan or holding that asset; whereas capital should be held against unquantifiable risk. But how do you know how much capital you should hold if the risk is unquantifiable? Fortunately, regulators are beginning to be able to answer that query via the use of stress tests, which examine whether each bank would still be viable, even after a severe, but feasible, adverse event. In my view, the introduction of stress tests has been the most beneficial improvement to the regulatory armoury since the Great Financial Crisis. In my view, the banks' capital requirements should increasingly be based on their resilience under stress test conditions, rather than either a risk-weighted or a simple leverage ratio, both of which have serious disadvantages.

The problem with liquidity requirements is that, so long as a bank maintains its good reputation, obtaining additional cash to meet net outflows in payments is hardly ever a significant or serious problem, but once a bank starts to lose its reputation, then the size, speed and scale of withdrawals can quickly multiply to a level that is hard to withstand. This is especially so when a bank is financed largely through the wholesale markets, rather than by retail deposits. Even when a bank is bailed out and nationalized, if it has lost its reputation the outflows may continue to be sizeable, as occurred for example in the case of Continental Illinois. I wonder if central banks realise how much extra liquidity they may have to inject into banks subject to the current fashionable bail-in process. In the case of such non-linearities, what is important is that the central bank gets an early and clear insight into the condition of the bank in difficulties and can make an informed judgement on

how best to proceed. The main advantage of the LCR (liquidity coverage ratio) is that this provides an early trigger for the central bank to get closely involved with that bank's affairs.

Financial regulation should be a field where utilization of big data and AI could potentially bring large benefits and cost savings. I would hope, and expect, that in future all transactions by financial intermediaries would get directly reported instantaneously to the regulatory authorities, without the financial institutions then having to fill in myriad additional forms. This would lead to a gigantic increase in the data available to the authorities, who could only deal with it through AI. If the regulatory authorities have access to all such information, they should be able to use technology and AI to work out all positions and interconnections, and to discern emerging points of fragility. In my view, financial regulation is a field ripe for technological improvement. With any luck this should happen over the next two decades. The resulting changes in approach and technique could be mind-boggling in extent and should happen.

*Q3. Some say that the heydays of central banking now lie behind us, and in the future we should expect a reduced relative independence of central banks. What are your thoughts concerning such prophecies?*

The only central bank that has become truly independent is the European Central Bank (ECB). The ECB is protected by treaty, which is extremely hard to reverse, whereas all other central banks have been established by legislative statute, which the legislature can reverse at their own discretion. Moreover, appointments to each central bank's management boards and top committees are under the control of the politicians. Although it is often difficult to dismiss intractable governors or other board/committee members, their time in office is limited, so, after some elapse of time, politicians can eventually and usually bend the membership of central bank management to do their wishes. Again, the ECB is something of an exception, because no one set of politicians can control board membership.

Be that as it may, future relationships between central banks and their political masters are likely to become more difficult and problematical over the future decades. Over the last three decades, the trend in both real and nominal interest rates has been steadily downwards. This has meant that central bankers have been the best friends of Ministers of Finance. Although most public sector debt ratios have been rising strongly in recent decades, this has been, almost exactly, counter-balanced by the fall in interest rates, leaving debt service ratios roughly constant. This will not persist. With nominal interest rates having hit a lower bound, there is only one way for them to go; upwards! What will happen to real interest rates is uncertain, since politicians, especially when facing elections, give a higher weight to growth than to inflation, and may pressurize central banks not to raise interest rates in pursuit of price stability. Current examples are obvious, especially with populist politicians.

There is a second, though in my view less important, reason to expect more political control and less independence for central banks. This is that, previously unconventional, monetary policies, such as macroprudential measures, now trespass into areas that are politically sensitive, notable the housing market, should central banks seek to maintain financial stability by introducing changes in mortgage conditions. Paul Tucker's recent book expands on this particular problem.

*Q4. The global financial crisis has been ascribed in large part to financial institutions taking on excessive debt. Yet, apart from the banks, where debt ratios have been reduced, subsequent monetary policy has encouraged, via extraordinarily low interest rates, the accumulation of debt in every other sector. Has this been a sensible policy; what are the dangers involved; and how do we get out of such difficulties?*

The world's major economies are, indeed, in, or close to, a debt trap. Debt ratios for non-financial corporates, public sectors in almost every country, (except Germany), and households in some countries, (including Sweden), have risen to such high levels that unless interest rates only increase gradually and by a very small amount, such indebted borrowers could well become unable to meet their interest costs and a recession would follow, provoking yet further falls in interest rates. Thus, the debt ratios are so high that interest rates have to remain stuck at such low levels as will continue to encourage yet further increases in debt.

How can we get out of this debt trap? The preferred method for doing so would be growth. But, unfortunately, demography, having again been remarkably favourable in recent decades, is currently turning against us. The rate of growth of working population in most of our countries is falling, and in many countries in Europe the workforce is actually now beginning to decline, following on from Japan. Indeed, Japan has actually done very well in macroeconomic terms. It has combined a decline in the available workforce averaging about 1% per annum with a rise in GDP, again of about 1% per annum, so output per worker in Japan has been rising at about 2% per annum, which is considerably faster than that in almost every other major economy.

Productivity per worker in these other major economies has actually been historically sluggish since the GFC. Unless it rebounds extraordinarily rapidly, the combination of a declining workforce and unremarkable productivity means that growth is likely to remain sluggish. There are reasons for some optimism that productivity may start increasing faster, in part because worsening demographic trends will bring more bargaining power and higher real wages to labour, so that employers will have to raise productivity to hold down unit labour costs. But even so, to expect growth to get us out of the debt trap is to ask for a miracle.

The second set of measures that could lead to some relaxation in the debt trap involves some form of repudiation of the debt itself. The easiest, and most likely, of these is faster inflation than is now expected. That is not difficult to foresee, especially with populist politicians, as indicated in my previous answer, but, of course, it runs counter to central banks' commitment to an inflation target of about 2%. Whether central banks can hold the line for price stability in future decades is clearly uncertain.

Other ways of repudiating the debt, are by straight default, or some form of renegotiation. Default has happened, but is an extreme solution and one not easily acceptable in advanced economies, and renegotiation is similarly subject to great difficulties.

There is an alternative option, which I would very much like to see preferred. This is to reverse the shift from equity finance into debt finance, by making equity finance more attractive to borrowers whether in the public sector, non-financial corporate sector or households. One key step in doing so would be to remove the fiscal advantages to debt finance. That should be pursued as a matter of priority.

But there are other problems. For example, how do you shift the public sector towards a form of equity finance? An answer to this would be the generalized adoption of nominal income bonds, rather than fixed interest bonds. Again, how do you get more equity finance into housing? If housing prices were expected to rise, borrowers would not be keen to incorporate an equity element into their borrowing, whereas lenders would be prepared to do so. Similarly, in a housing bust, borrowers might be keen on an equity element, though lenders would not be. There are ways of getting around this particular problem; borrowers might be required to incorporate an equity element into their borrowing, and in downturns, the public sector should be capable of standing in to provide the equity element that borrowers would be keen to have.

In the case of corporates, the governance and remuneration of management leads them to want to maximise the return on equity (RoE). They can most easily do so by increasing leverage, e.g. via buy-backs. What is needed here is a change to the governance structure for corporates, whereby top management is remunerated in a manner that does lead them to prefer equity finance, and resilience in downturns, over debt finance and higher RoE. This latter is a field in which I am currently working, hoping to produce a paper shortly with Rosa Lastra on this topic. Such corporate governance issues, in my view, represent some of the most important matters for reform within the current financial system.

*Thank you very much!*

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