From the Lab

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A Message from the Director

Finn Kydland

This issue is devoted in large part to summaries of the presentations and discussions at two LAEF conferences held last October. The objective of the first, "Micro and Macro Labor Models," was to bring together economists who seek to develop models of the labor market, models that can be used better to understand labor market outcomes and address a broad range of issues related to the working of the labor market.

LAEF sponsored this sixth in an ongoing series of conferences that have brought together researchers who use models to analyze both micro and macro labor-market data. Previous conferences were held at Arizona State University, Yale University, University of Chicago, University College London, and Aarhus University. The academic organizers of the conference were: Richard Rogerson, Rondthaler Professor and Regents Professor in the Department of Economics, W.P. Carey School of Business at Arizona State University, and Víctor Ríos-Rull, Professor of Economics-Carlson Chair, University of Minnesota.

From time to time, we have entertained the idea of organizing a conference jointly with some other university or research institution. The first such joint conference was held in Pittsburgh in co-operation with the Tepper School of Business at Carnegie Mellon University. The expenses were shared approximately equally. Three of UCSB's economics PhD students were flown to Pittsburgh to attend and to summarize the conference.

As the title, "Advances in Macro-Finance," suggests, the conference focused on research at the interface of macro and finance, especially on the relationship between asset prices and macroeconomic fundamentals. Topics included, but were not limited to: production economies; exotic preferences; time variation in expected returns; learning; and pricing of currencies, commodities, and sovereign debt. Preference was given to recent papers that had not previously been presented at major conferences.

Conference organizers were Lars-Alexander Kuehn and Nicolas Petrosky-Nadeau, both Assistant Professors of Economics at the Tepper School. To the extent possible, the organizers paired authors to discussants with different backgrounds (macroeconomics and finance), with senior academics discussing the work of junior colleagues.

Also, in a busy last October, LAEF had a one-week visit from Bill Gavin, Vice President at the Federal Reserve Bank of St. Louis. Bill came to work on a joint research project with me on Monetary Policy, the Tax Code, and Energy Price Shocks. While at LAEF, Bill found time to give a public lecture on The Zero Lower Bound: Avoidance and Escape! More about Bill Gavin on page 19.

The next issue of From the Lab will feature the proceedings of the November 2010 "Growth and Development" conference hosted by LAEF.

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Micro and Macro Labor Models

OCTOBER 1–2, 2010

VISITING CONFERENCE PARTICIPANTS

Rudi Bachmann – *University of Michigan*
Bjoern Bruegemann – *Yale*
Andrès Erosa – *IMDEA*
Jason Faberman – *Federal Reserve Bank of Philadelphia*
Eric French – *Federal Reserve Bank of Chicago*
Limor Golan – *Carnegie Mellon University*
Fatih Guvenen – *University of Minnesota*
Gary Hansen – *University of California, Los Angeles*
Andreas Hornstein – *Federal Reserve Bank of Richmond*
John Kennan – *University of Wisconsin-Madison*
Guy Laroque – *ENSAE*
Rasmus Lentz – *University of Wisconsin-Madison*
Lars Ljungqvist – *Stockholm School of Economics*
Iiouri Manovskii – *University of Pennsylvania*
Nicolas Petrosky-Nadeau – *Carnegie Mellon University*
Luigi Pistaferri – *Stanford and NBER*
José-Víctor Ríos-Rull – *University of Minnesota*
Jean-Marc Robin – *Sciences Po, Paris*
Richard Rogerson – *Arizona State University*
Robert Shimer – *University of Chicago*
Chris Taber – *University of Wisconsin-Madison*
Irina Telyukova – *University of California, San Diego*

The full model fits the amplification and persistence of labor market tightness better than the model with only labor frictions. The authors conclude that the credit market imperfections amplify the response of labor market tightness to productivity, while the goods market imperfections provide both amplification and persistence. The importance of the goods market is seen in the sensitivity of the persistence results to a decrease in the consumer bargaining weight and the use of a fixed price. The time it takes to build a consumer base plays an important role. The dynamics of congestion and prices on the goods market induce increasing incentives to hire, even as productivity is returning to the trend.

The discussant, Peter Rupert, recognized that if the presence of one black box was not enough, this paper takes on the ambitious task of looking into three black boxes. The results for the model with credit and labor frictions look very similar to the results for a model with only a labor friction. This makes the credit market friction appear to be less important than it is in reality. Rupert questioned whether there actually is a credit market friction in the model. The credit market is not affected by the state of the economy and there is no link between the capital structure and the size of the firm. The way the credit market imperfections are modeled here they do not appear to matter in the results. Rupert also mentioned the issue of how to calibrate the rate at which a firm meets a banker in the credit market. The author responded that they see the credit market friction as the complicated process of finding an investment banker.

Labor Market Friction, Firm Heterogeneity and Aggregate Employment and Productivity

by Rasmus Lentz and Dale T. Mortensen

Lentz and Mortensen seek to analyze innovations within firms and how this affects productivity and employment. The authors use a Klette-Kortum type heterogeneous firm model with firms innovating to create different intermediate good varieties and an equilibrium search model. The paper extends Lentz-Mortensen (2008) which focuses on the implications for firm growth through product innovation. The model is used to match several facts including the large amount of wage and productivity dispersion, the larger size of more productive firms, positive correlation between firm productivity and wages, and workers moving from low to high wage jobs. A conference participant asked what is meant in this paper by productivity, to which Lentz responded that for the empirical facts this is an observable productivity measure like output per worker or TFP. One goal is then to think about some reasonable mapping from these observables to the firm productivity in the model.

The model uses a CES production function to convert intermediate products into the final good which is used for consumption and investment. To produce intermediate goods, firms need labor from a market with search frictions. The firms innovate to find new products and these product lines are destroyed at an exogenous rate. Once a firm has no products remaining it closes. When asked why the authors assume a Poisson arrival rate of innovations, Lentz stated that this method seems to best fit the data and gives rise to essentially constant returns to innovation. In the data, a product line is seen as one establishment of a firm. Firms optimize by choosing an innovation rate and recruiting intensity for each product line in equilibrium.

One difficultly with the approach is how to separately identify the innovation rate from recruiting intensity in the data. To address this issue, the authors examine the distribution of firm types within a particular cohort and compare it to all existing firms. Over time, some firms will be lucky and have good draws of TFP for the product lines. This implies that larger firms have higher output per worker. One participant wondered if, then, it is important that search costs do not increase with firm size. Lentz responded that if you were to do this, you would end up with dispersion in worker output, but not a systematic difference in productivity across product lines.

As an example, Lentz and Mortensen simulate the model for two types of firms, which differ in their distributions of product line TFP, one type getting better draws on average. What is shown is a comparison between the economy with and without heterogeneity across the distributions. The authors highlight that we can see the changes in composition of a cohort over time, as compared to all firm, as better firms with better product lines are selected into the economy.

Jason Faberman discussed the paper, summarizing the contribution of the paper as an augmentation of Lentz-Mortensen (2008) that adds job-to-job transitions for a more complete description of firm and wage dynamics. To simplify the potentially complex analysis of surplus between individual workers and firms, the authors instead describe everything at the level of the product lines. Faberman stated that the model is useful to describe firm entry and exit and behavior of workers and firms, but perhaps will not be able to match other important facts such as those affected by job-to-job transitions and job separations.

Innovation, Growth and Asset Pricing

by Howard Kung and Lukas Schmid

Kung and Schmid investigate the relationship between endogenous growth through investment in research and development (R&D), risk and asset prices. Innovation and R&D are two main drivers of growth. The risk premia in asset markets can be linked to the sources of growth and in turn affect the incentive to innovate. The question is how macroeconomic risk affects growth and what mechanisms and incentives possibly drive such fluctuations. As a policy implication, this could shed light on the desirability of monetary and fiscal stabilization policies through their effects on long-run growth.

The authors' model features a representative agent with Epstein-Zin preferences who dislikes risk to long-run growth rates. A final good is produced using labor, capital and a continuum of intermediate goods (a Dixit-Stiglitz aggregator). Labor productivity is subject to business-cycle style exogenous shocks, however, with a stationary distribution. Firms producing the intermediate goods have patents for their products and engage in monopolistic competition. Patents can be bought from the competitive R&D sector, which produces them at constant returns to scale from an individual firm's perspective, but is subject to a congestion externality. Labor supply is exogenous. The final good is used for consumption and as an input to produce capital, intermediate goods and research. Growth occurs endogenously as the research sector provides an ever-expanding variety of blueprints for intermediate goods, which increases productivity in the final goods sector.

When the economy is hit by a positive shock to labor productivity, the demand for intermediate goods increases and thus also the profits of the firms producing them. This in turn triggers a rise in R&D expenditure, as innovators can sell their patents for a higher price. Thus, a wider variety of intermediate inputs is produced, which leads to higher productivity, albeit with a delay. Hence, exogenous shocks to labor productivity lead to standard short-run business cycles but also to long-run changes to the growth rate. Due to households' recursive preference structure, this additional volatility (as compared to a model with exogenous growth) leads to a high risk-premium of stocks relative to risk-free bonds (which are in zero supply). If the economy is more volatile, i.e., exogenous productivity shocks have a higher variance, this will drive up the risk-premium and thereby trigger more investment in research, and as a corollary, the growth rate, too. Optimal growth is inherently risky, since households invest in R&D pro-cyclically and generate additional fluctuations in the long-run growth rate. The calibrated model matches key facts on growth and asset pricing quantitatively. R&D expenditure is found to be a predictor of growth both in the model and empirically.

The paper's discussant was Thomas Tallarini. He wondered about the potential effects of an elastic labor supply. For example, a positive shock to labor productivity might lead to wealth effects, inducing agents to work less, which could change the implications slightly. Similarly, the way adjustments costs to capital are modelled has a quantitative impact on predictions. Tallarini speculated whether this new link between volatility and growth implied that stabilization policies are not as desirable as previously thought. A conference participant asked how far the paper can contribute to the debate on these policies. Schmid replied that it is difficult to conduct welfare analysis in the model but that a stabilization policy, if successful, could harm growth.

Dividend Strips and the Term Structure of Growth

by Jules van Binsbergen and Ralph Koijen

Expectations of future growth are an important factor in the decision making process of households, firms and governments. Predicting economic growth has been empirically difficult, and the best predictor so far is based on the term structure of interest rates. The main contribution of the van Binsbergen-Koijen paper is the use of a new dataset on dividend futures to extract risk-adjusted growth expectations. These dividend futures are significant leading indicators of consumption, dividends, and GDP. Finally, the term structure of expected growth rates allows an alternative evaluation of important events, such as the global financial crisis of 2007/08.

Compared to aggregate stock market data, the advantage of dividend futures is the different maturity structures, which allows one to distinguish between short- and long-term growth expectations. Both stock market data and dividend futures rely not only on growth expectations, but also on time-varying discount rates, which are thought to be the dominant factor. The authors therefore rely on risk-adjusted growth rates.

The dataset consists of daily dividend future data from several major market participants and leading stock indices from the United States (S&P 500), Europe (Euro Stoxx 50), and Japan (Nikkei 225) to impute dividends. Dividend strips were at first traded in over-the-counter markets and since 2008/09 in an exchange market.

From the dividend strip curve that has been discussed in a companion paper, three observations stand out: the risk premium, volatility and Sharpe ratio go down over time, which is at odds with the predictions of leading as-

set pricing models. They imply that the long-run risk is primarily responsible for the equity premium, while the data seems to imply a higher short-run risk.

Concerning expected risk-adjusted growth rates, the authors find that short-term growth rates were decreasing very steeply, whereas longer-term growth rates were actually increasing. However, taken together, the expected ten-year growth rate was still lower when the crisis hit.

Regarding the importance of events, the bankruptcy of Lehmann Brothers, for example, did not have the biggest impact on dividend futures, but instead former Federal Reserve Chairman Alan Greenspan's testimony before Congress influenced five-year growth rates more. Finally, implied risk-adjusted expected ten-year growth rates as of October 13, 2010 are much higher for the United States than for either Europe or Japan, at 4.3%, -0.2% and -1% respectively. This could reflect any combination of higher growth rates, higher inflation rates and a lower risk premium for the United States as compared to the two other regions.

The discussant for this paper was Adlai Fisher. He mentioned the short sample-length and lacking statistical significance of some of the estimates for the dividend strip curve. Compared to the authors' previous paper, measurement error for daily data is probably higher than for the monthly data. Furthermore, it might be interesting to know who is trading dividend futures and for what motive; for example, to hedge risks or for tax reasons. To get at the term-structure of economic growth, it is imperative to distinguish between growth and risk premia, to consider total payouts versus dividends (such as share repurchases), and total output versus dividends (thinking of reinvestment and non-public firms). A conference participant asked about companies' hesitation to cut dividends. It was argued that if there is a cut, it might be a high marginal utility state, thus dividends might command a higher risk premium.

Credit Shocks and Aggregate Fluctuations in an Economy with Production Heterogeneity

by Aubhik Kahn and Julia Thomas

Standard real business cycle models predict that a reduction in aggregate capital implied by a temporary tightening of credit markets cannot yield sizable or persistent real aggregate effects, since investment is a small fraction of aggregate output. However, the recent financial crisis and the recession that ensued suggest otherwise. Kahn and Thomas ask whether a temporary crisis in financial markets can generate a large and persistent drop in aggregate productivity by disrupting the distribution of capital away from that implied by the firms' relative productivities. To answer this question, the authors propose a general equilibrium model economy with financial frictions wherein firms face persistent shocks to both aggregate and individual productivity, and study the effect of a financial shock on real business cycle fluctuations. They find that aggregate responses to real shocks are largely unaffected by the presence of financial frictions, while an unanticipated tightening in borrowing conditions in the model can generate a large recession outlasting the financial shock itself. Furthermore, the recovery that follows is led by a rise in business fixed investment, rather than in household consumption spending.

Central to the Kahn-Thomas model are two interacting financial frictions distorting the optimal reallocation of capital. First, collateralized borrowing constraints limit how much small firms with relatively high productivities can invest. Second, asymmetric capital adjustment cost faced by firms gives rise to two-sided (s,S) investment decision rules. That is, the presence of a linear penalty for negative capital adjustments implies that firms with capital stock above the (s,S) inactivity range only reduce their capital stock to the upper bound (S) of the range, while firms with too little capital invest only up to the lower bound (s) as their productivity could rise in the future forcing them to decrease their capital stock. The second friction compounds the first one so that large and relatively unproductive firms may hold a disproportionate share of the aggregate capital stock, thereby reducing endogenous aggregate total factor productivity (TFP). The partial irreversibility of investment induces both downward and upward inertia in firm-level capital adjustment, so that the effect of a temporary tightening in financial markets is not quickly reversed. Kahn and Thomas show that with persistent heterogeneity in both capital and total factor productivity, the effects of a financial shock can be amplified and propagated through large and long-lived disruptions to the distribution of capital, which implies large and persistent reductions in aggregate TFP.

Gian Luca Clementi discussed the paper. He began his discussion by contrasting the model's microeconomic and macroeconomic implications with recent empirical evidence on the financial behavior of firms, and with some features of the recent recession. The Kahn-Thomas model predicts that (i) large firms pay more dividends; (ii) book leverage is decreasing with firm size; and (iii) book leverage is positively correlated with the investment rate. Clementi pointed out that recent studies generally support the first implication, but not the other two. For instance, leverage ratios are typically found to be increasing in the size of firms, regardless of whether or not the firm is private. Furthermore, firms' leverage is

specific controls – and excess bond premium – the residuals of this regression. They then show that the excess bond premium carries most of the credit spread's predictive content. Zhang warned that this approach may be subject to specification errors as all credit risk models are nonlinear in nature, while this approach is linear. That is, the credit spread could be driven by systematic risk due to rating agencies underestimating credit risk by using Merton-style models. Zhang finally suggested trying the time-tested predictive regression approach in the spirit of Fama and French (1989) to link the credit spread to risk premiums.

Liquidity and Asset Market Dynamics

by Guillaume Rocheteau and Randall Wright

Housing prices rose quickly in the 2000s only to end with an abrupt collapse. Price growth not explained by fundamentals alone has been called a bubble. Rocheteau and Wright seek to generate such price behavior, not with irrationality or complicated beliefs, but by allowing liquidity to be valued. Kocherlakota (1998) notes that money becomes essential when agents are faced with a double coincidence of wants problem with imperfect enforcement and anonymity. Rocheteau and Wright use similar assumptions to make the collateralizable asset essential. When the asset is in fixed supply, and entrepreneurs are borrowing constrained, its ability to provide liquidity, or collateral, commands a premium.

The authors' paper advances the literature by creating a model in which the liquidity premium fluctuates without any external shock. Two different consumption goods are produced and consumed in two different markets: a frictionless centralized market and a decentralized market. The decentralized market is one with bilateral matching and bargaining, and consumption must be financed through debt. This debt will be secured through an asset in fixed supply which serves as collateral. Sellers decide whether to participate in this market: higher asset prices encourage participation, but there is a fixed entry cost. A market with many sellers makes the matching probability attractive for buyers, who in turn want to hold more of the asset for liquidity purposes. These dynamics generate multiple equilibria, and a positive correlation between asset prices, market capitalization, output and welfare. The result is an asset price that fluctuates over time endogenously, in what the authors term "a self-fulfilling prophecy." Uncertainty is introduced in the form of a sunspot variable, to shock prices and market tightness. The main finding is that even when the low shock is sufficient to completely shut down the decentralized market, the asset still commands a liquidity premium due to the expectation that the asset will have value in the future.

A conference participant asked if the asset providing liquidity could be interpreted as housing or stocks. Rocheteau replied that the asset could be either; it is modeled as a Lucas tree, but it can represent a broad class of assets, providing a general explanation for price fluctuations in many markets. Ben Lester discussed the paper, highlighting the positive effects of bubbles. When asset prices increase, wealth increases, facilitating trade. Policy implications seem similar to previous bubble literature, where the bubble is created from the demand for liquidity: if the government issues bonds to satiate liquidity demand, the equilibrium is unique and assets are priced according to the discounted value of future price and dividend alone.

Bubbly Liquidity

by Emmanuel Farhi and Jean Tirole

Fahri and Tirole use a corporate finance perspective on bubbles to extend the literature by asking the following questions: What role do financial institutions play? Do bubbles raise interest rates and crowd out productive investment? Do bubbles alter the financial structure of firms? Are some firms hurt more than others? Can public policy decrease the probability of a bubble? And, is there an appropriate test for the existence of bubbles? To answer these questions, the authors use a standard growth model with overlapping generations of risk-neutral entrepreneurs with a constant-returns-to-scale technology. The young are endowed with some asset which they will invest in others' investment projects, trees and the bubble. The tree is in fixed supply and pays off a deterministic amount in dividends. The other source of outside liquidity is a bubble which grows at the interest rate, but is intrinsically worthless. When middle aged they receive their returns to their investments and invest in their own project, returns of which are realized when old and the entrepreneur consumes. Entrepreneurs are borrowing constrained; they can only pledge a fraction of future revenue from production. Financing production depends on this fraction (inside liquidity), and the amount of outside liquidity available (trees and the bubble).

More investment by the young implies a greater return next period, so that more investment in their own project is possible the following period. Increasing outside liquidity increases investment, but also raises the interest rate making financing harder, and therefore decreasing leverage. The net effect is ambiguous. In the bubbleless economy, investment increases with outside liquidity, the tree, when the interest rate is high enough. In the "bub-

bly economy" bubbles emerge when inside and outside liquidity is scarce. The bubbly steady state always has more investment than the bubbleless, but if the bubble bursts, investment falls and there is convergence to the bubbleless steady state. When firms are heterogeneous, those with less pledgeable returns benefit more from the bubble, and hold more of it, but are also made worse off when it bursts.

Adriano Rampini discussed the model's answers to the questions posed above. There is no definitive test for bubbles, but an interest rate lower than the growth of the economy is a necessary, albeit not sufficient, condition for a bubble. Bubbles do not lead to Pareto improvements because tree holders lose from bubble emergence. Even crashes are not Pareto dominated by non-crashes. What then are policy implications? With more liquidity, bubbles are less likely, or smaller. Government can then control liquidity supply with public debt and interest rates. Rampini questioned the implications regarding procyclical/countercyclical capital asset ratios.

Growth Opportunities, Technology Shocks and Asset Prices

by Leonid Kogan and Dimitris Papanikolaou

In the finance literature, the mix of the value of current assets and growth opportunities is thought to be a potentially important source for differing risk premia across firms. At the same time, in macroeconomics, investment specific shocks are considered to affect aggregate growth and business cycles. Kogan and Papanikolaou evaluate the impact of such shocks on asset prices and risk premia using a structural calibrated model.

In the authors' model, there are firms with access to projects which arrive at random. Firms with a high arrival rate of projects are termed high-growth. The profitability of a new project depends on the price of capital – the lower the cost of investment, the higher the expected profits. The value of a firm, defined as the expected value of future cash-flows, is decomposed into the value of existing projects and the value of potential projects. Thus, a high-growth firm will have a higher share of its value in growth prospects. Since a project's capital investment has to be determined once and for all when the project starts, only potential future projects are subject to investment specific shocks (which are defined as shocks to the price of capital). Aggregate productivity shocks, however, affect both current and future projects in the same way.

States with low capital costs are associated with high marginal utility, as productivity remains the same but more resources are invested instead of consumed (which is also confirmed in the calibration). It follows that the risk premium for a high-growth firm should be lower than that of a low-growth firm. Shares of high-growth firms are subject to an additional systematic risk, but they pay off in states where the value of resources is higher. This also implies that there should be a positive correlation between book-to-market ratios and excess returns. This ratio corresponds to the relative share of the value of current projects in the total value of the firm. A high-growth firm will thus have a low book-to-market ratio and lower excess returns, as had been documented before in the data. Furthermore, investment as a fraction of installed capital of high-growth firms is relatively higher and more susceptible to investment-specific shocks. These model predictions match empirical observations qualitatively and quantitatively.

Jesus Fernandez-Villaverde was the discussant for this paper. He pointed out that the dynamics of installation costs could be different from the dynamics of the relative price of capital. For example, a factory needs to be built (requiring land and labor); permits need to be obtained; etc. Furthermore, in the model, only new projects are subject to investment-specific shocks. However, current projects require maintenance and overhaul, which can be quantitatively very important. If these costs are also affected by the cost of capital, then current projects would change in value in response to such a shock, too. At the same time, the binary choice of starting a project immediately or discarding it forever exposes growth firms to investment shocks more: if the firms could put a project on hold, they could reduce their risk. A conference participant asked how much the price of investment has any impact on business cycles and consumption (and thereby marginal utility). Papanikolaou replied that the price of investment might not be a good measure of an investment shock, as it is endogenously determined by demand and supply. Investment shocks could also be interpreted as financial shocks, but these two are isomorphic in the model: whether the physical or financial cost of investment changes is irrelevant.

Rare Disasters and Risk Sharing with Heterogeneous Beliefs

by Hui Chen, Scott Joslin and Ngoc-Khanh Tran

What happens to the equity premium when agents have heterogeneous beliefs about disasters? Specifically, what if one group has correct beliefs, and another has incorrect optimistic beliefs about the intensity of a disaster? The Chen-Joslin-Tran paper finds a non-linear relationship between the disaster loss and the risk premium, causing a small amount of risk sharing to have a

significant impact on the equity premium. Even though the agents with correct beliefs will come to control all of the wealth in the limit, the incorrect optimistic agents can have a significant impact on the equity premium for a long stretch of time due to their ability to retain and accumulate wealth. The authors tried to reverse the effect by allowing the pessimistic agents to be overly pessimistic; they now anticipate a disaster with greater intensity. The optimistic agents, even if only in control of a small fraction of aggregate wealth, still decrease the equity premium.

Agents trade three securities: a risk-free asset, a claim to aggregate consumption, and disaster insurance. The aggregate endowment evolves according to Brownian motion until a level shock hits, representing the disaster. For the calibrated economy, the pessimists believe that disaster risk for the United States is the same as that of the rest of the world. The optimist believes that the U.S. is special, and assigns less probability to large disasters, but believes smaller troubles are more likely. The pessimist reduces her consumption loss in large disasters and provides insurance to the optimist over smaller disasters. The equity premium decreases as the share of wealth owned by the optimist increases because she is willing to insure the pessimist against the states he fears the most. There is an exponential drop in the equity premium as the wealth share of the optimist increases from zero to ten percent, and then levels off.

The paper's discussant, Rajnish Mehra, explained that all asset pricing is about consumption smoothing, and this paper is no exception. With optimistic agents readily insuring the pessimists against the worst states, the equity premium quickly falls. Mehra pointed out that the analysis requires one group have to correct beliefs; if both types were to have incorrect beliefs, the analysis becomes much more difficult. The complete markets assumption leaves the paper open for extension, as collateral constraints would be a natural assumption when modeling disaster insurance. A conference participant wondered if the results would be symmetrical if a small portion of pessimistic, rather than optimistic, agents were added. Would the equity premium substantially rise? Chen replied that adding a small fraction of pessimistic agents would move the equity premium along the flatter part of the curve. A majority would have to be incorrectly pessimistic before great changes in the equity premium could be observed.

International Risk Cycles

by Francois Gourio, Michael Siemer and Adrien Verdelhan

International real business cycles (IRBC) models are inconsistent with basic features of asset prices and exchange rates, such as volatility, cross-country correlation, and their correlation with macroeconomic aggregates. Moreover, this class of model implies equity and currency risk premia that are too small compared to the average excess returns documented in the empirical finance literature. In this paper, Gourio, Siemer, and Verdelhan investigate whether the puzzling feature of international asset markets are the consequence of disaster risk. To this end, the authors extended the IRBC model of Backus, Kehoe and Kydland (1992) by introducing recursive preferences, a small and stochastically time-varying risk of economic disaster, and making the two countries differ in their exposures to aggregate risk. Gourio, Siemer, and Verdelhan show that augmenting the model this way yields (i) real exchange rates that are about two times more volatile; (ii) macroeconomic aggregates that are more correlated than can be accounted for solely by TFP shocks; (iii) asset returns that are more correlated across countries than macroeconomic aggregates; (iv) less than half the correlation of relative consumption growth and the exchange rate; and (v) a four percent annual average excess return as compared to a standard IRBC model. Nevertheless, the model is at odds with data in as much as it predicts that high interest rate countries are less volatile because they are less sensitive to variations in disaster risk, while it is the reverse in the data: high interest rate countries have higher volatility of both quantities and equity prices.

The economic disaster enters the model through the capital accumulation of the representative firm. There is a time-varying low probability of having a large portion of the capital stock destroyed, and recursive preferences are set so that the risk-aversion is higher than the inverse of the inter-temporal elasticity of substitution, which implies that agents prefer an early resolution of uncertainty. This, in turn, generated risky return on capital, and variations in disaster risk lead not only to changes in risk premia and asset prices, but also to variations in macroeconomic quantities. For instance, an increase in the probability of disaster leads to a decline of investment and output, because higher uncertainty makes it less attractive to hold risky capital. Demand for safe assets increases, causing the yield on these assets to fall, while the spread on risky securities increase. The aforementioned business cycle dynamics occur with no change in TFP. In the present version of the model, the two countries are assumed to have different levels of exposure toward aggregate risk so that recessions and declines in

stock prices are stronger in the more risky country, and the exchange rate of the less risky country depreciates. In this paper, the authors consider an equilibrium with zero net trade, but complete asset markets preventing risk-sharing.

Stan Zin discussed the authors' paper, focusing on its technical aspect. Zin first explained that the main innovation of this model is the use of recursive preference together with a small probability of extreme negative events in an otherwise standard IRBC model. Total factor productivity shocks are independently and identically distributed, while disaster shocks are persistent. Recursive preferences imply the possibility of a rare but extreme negative event affects the thickness of the tail of probability distribution of future utility, which then feeds into the stochastic discount factor and affect asset prices. Thus, persistence in this model is not due to persistent TFP shocks, but is due to persistent and rare disasters, which can be interpreted as preference shocks. As a result, an upward jump in the probability of the rare disaster without the disaster actually occurring, raises the stochastic discount factor, leading to a decrease in investment and labor, and a fall in output and asset returns. Zin then commented on the solution algorithm proposed in the paper. The authors simplify the computation by considering a small and a large economy. Trade with the small economy is set to zero, and does not affect the determination of equilibrium prices in world asset markets. Therefore, the small economy takes world prices as given, and the large economy is used to generate the price process with jumps correlated with the probability of disaster. This, Zin argued, is a rather computationally costly way to build cross-country correlations into disaster shocks, and suggested using an exogenous price process. He argued doing this should not remove much of the novel qualitative and quantitative insights of the model, but would reduce the computational burden while possibly allowing one to concentrate on other interesting aspects of the model.

The Zero Lower Bound: Avoidance and Escape!

A lecture presented by Dr. William T. Gavin

William T. Gavin, vice president and economist in the research department of the Federal Reserve Bank of St. Louis, presented a public lecture at UC Santa Barbara on Wednesday, October 27. His presentation was entitled "The Zero Lower Bound: Avoidance and Escape!"

In his talk, Dr. Gavin focused on why the federal funds interest rate target is set at zero — the lower bound on market interest rates — and why it is a trap. He discussed how policies can be modified to avoid hitting the zero lower bound, and, perhaps most importantly for today, how implementing such modifications might help to escape a zero lower bound.

In his position at the St. Louis Federal Reserve Bank, Dr. Gavin participates in management, serves as editor-in-chief of Review — the Bank's bimonthly economic research journal—and conducts economic research. Currently, he is studying the interaction between monetary policy and the market for risky debt. His scholarly work, which appears in a wide variety of academic, business, and Federal Reserve System publications, is centered on both theoretical and statistical analysis of U.S. monetary policy. His applied theoretical work uses computational techniques to evaluate policy in complex and uncertain environments.

Dr. Gavin is a member of the National Association of Business Economists, the Society for Economic Dynamics, and the American Economic Association. He has served as an adjunct professor of economics at Case Western Reserve University, Cleveland State University, and Washington University in St. Louis.

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Summaries of each of the presentations follow.
Note: speakers and discussants are highlighted.

A Micro-Founded Theory of Aggregate Labor Supply with Non-linear Wages
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A Micro-Founded Theory of Aggregate Labor Supply with Non-linear Wages

by Andres Erosa, Luisa Fuster and Gueorgui Kambourov

An area of debate in the labor literature is the effect of macroeconomic shocks on aggregate labor supply. Specifically, the labor supply elasticity used in macroeconomic models is much larger than one would estimate using micro-level data. Erosa and Kambourov seek to create a micro-founded theory of aggregate labor supply to shed light on this relationship. They find a neoclassical model with non-linear wages, indivisible labor, and heterogeneous agents can account for several prominent features of life-cycle labor supply. They also show that labor supply elasticity in their model with non-linear wages is much higher than that generated by the Frisch-elasticity of labor supply.

Erosa and Kambourov explore the PSID and SIPP to gather facts about male labor supply on both the intensive and extensive margin to motivate the model. Their findings are that hours worked over the life-cycle and dispersion of hours form an inverted U, the dispersion of hours is quite high, non-college workers have more variation in hours than college educated workers, and hours are very persistent over the life-cycle. In consideration of these facts, the authors create an overlapping generations model with heterogeneity in labor productivity and education, education being exogenous. In their model, individuals have a probability of dying each period that depends on their age and education and they have preferences over consumption and leisure, which allows for an active extensive margin in terms of leisure. Non-linear wages are a crucial part for generating the model's result and so an individual's earnings are a concave function of how many hours they work. A model with only linear wages will not account for the extensive margin and a model with linear wages and a fixed cost of work will not match the micro facts. Labor productivity follows a stochastic process which is a function of a quartic in age, individual fixed effects, a persistence component, and a transitory shock. The role of government in their model is to tax income and provide a social security system. There is no borrowing and no insurance of labor income risk; however, individuals can insure mortality risk through annuity markets.

To calibrate the model, Erosa and Kambourov set most of the parameters equal to the standard values in the literature. Calibrating the stochastic process on labor productivity is not as straightforward; therefore, the authors use an indirect inference approach to retrieve this process. The baseline model, the one focused on when considering the performance of the model, was calibrated to have a non-linear wage economy with a Frisch elasticity of leisure equal to negative one half. Erosa and Kambourov

find that this baseline model performed well in capturing most of the qualitative facts of labor supply observed in the data. Specifically, the model can predict the shape of the age-hours profile up until late in the life-cycle, the shape of dispersion in hours of work, persistence in annual hours worked, the cluster around 600 hours in the distribution of hours, and the negative correlation between the change in log hours and change in log wages. Quantitatively, the model falls short on several of these facts. A participant commented that from looking at the pictures, Erosa and Kambourov might want to add more heterogeneity since the action you get from the extensive margin depends on it.

The final result of this paper is how aggregate labor supply responds to a temporary wage change. Erosa and Kambourov find that a temporary 2% increase in the wage causes results in a labor supply elasticity of 1.27, which is much higher than the Frisch-elasticity of labor supply. The extensive margin plays a large role in this high elasticity.

The discussant, Limor Golan, concluded that the main motivation of the paper is to develop a macroeconomic model of labor supply with non-linear mappings between hours and wages that can generate labor supply responses at the extensive margin. Though Golan thinks the model performs well qualitatively, it does not do so well on the quantitative end. A next step might be to have heterogeneity not just in labor productivity and education, but also in preferences.

Adjustment Costs, Firm Responses, and Labor Supply Elasticities: Evidence from Danish Tax Records

by Raj Chetty, John N. Friedman, Tore Olsen, and Luigi Pistaferri

The literature on taxation and labor supply generally assumes that workers can freely choose the quantity of labor. This paper looks at the case where frictions might not allow for an individual to choose their optimal labor supply. The paper also addresses the difference between macro and micro labor supply elasticities. Most of the literature finds the intensive margin elasticity to be close to zero. The existence of frictions can cause workers to appear more inelastic in the short run. This implies that the micro elasticity estimates are attenuated in comparison to elasticity estimates in a macro setting.

The frictions present in this model are the search costs associated with finding an optimal job and an hours constraint imposed by firms. These frictions prevent workers from freely choosing their hours, especially in response to short run marginal tax rate changes. The model has firms posting jobs with different hours requirements and workers paying search costs to find jobs. Following Saez (2009), the structural elasticity is identified by the amount of bunching at a variation in the tax rate.

The model makes three predictions based on kinks in the budget constraint created by steps in the tax schedule. First, the model predicts that larger kinks generate larger taxable income elasticities. Regarding scope, the model predicts that kinks that apply to a larger group of workers generate larger elasticities. The final prediction of the model is that the distribution of job offers is correlated with the workers' aggregate tax preferences in equilibrium.

The data comes from a panel of tax records for the population of Denmark. The marginal tax rate on earned income in Denmark has two steps. At the first step, the rate rises from 45% to 50% and at the second step, the rate rises from 50% to 65%. A conference participant asked how to think of the kinks in comparison to the U.S. tax system. In the U.S. tax code the large number of deductions and exemptions could lead to many different tax rates. The Danish setting is a more simplified setting with two steps in the tax schedule and a majority of workers take no deductions.

A question arose among conference participants about the existence of workers with multiple jobs. The model assumes that a worker only has one job and that data is at the total income level. A way for a worker in the data to get around a firm hours constraint is to take on a second job. This could attenuate the results, but would not eliminate the search cost friction.

The first prediction says that a larger kink will create more bunching since there is more of an incentive to pay the search costs. The larger, top kink has significantly more bunching than the smaller, lower kink. The second prediction is that firms will bunch at kinks since firms tailor jobs to aggregate preferences. There is evidence of firm bunching at the statutory top kink since individuals who do not face a change in their tax incentives are found to bunch there. The results show observed elasticities larger for tax changes that have larger size and scope.

The discussant, John Kennan, pointed out that this paper is a great example of people responding to incentives. The lasting image of the paper is the perfect tracking of the income bunching at the tax kink points for each year. Kennan also added that it would be informative to know how income tracks the kink. He offered the possibilities that the change could be driven by variation in hours worked or changes in labor contracts.

Taxation of Human Capital and Wage Inequality: A Cross-Country Analysis

by Fatih Guvenen, Burhan Kuruscu and Serdar Ozkan

Since the 1970s, wage dispersion has been significantly higher in the United States than in the continental European countries (CEU). During the same period, the inequality gap has been widening between the United States and the CEU. The wage dispersion over time has increased for both the US and CEU, but the gap in the U.S. has increased by more than in the CEU.

Guvenen, Kuruscu and Ozkan present two new empirical facts linking inequality differences to tax policies. The first is that, at different points in time, a more progressive income tax schedule is correlated with a lower before-tax wage inequality. The second is that a more progressive income tax schedule is correlated with less of a change in wage inequality over time.

The contribution of this paper is examining the role of income tax policies with respect to wage dispersion differences between the U.S. and CEU. The emphasis is on how progressive income taxation can distort incentives for accumulating human capital and compress the wage distribution. The theoretical model of human capital accumulation shows that reduced incentives should deter one from acquiring a costly education. This mechanism is seen in the optimality condition of a Ben-Porath model with taxes and labor supply. In the case with inelastic labor and progressive taxes the distribution of human capital is compressed. In the case of elastic labor and flat rate taxes, higher taxes reduce labor supply and investment is depressed. A question from a participant helped clarify that this amplification channel between labor supply and human capital is important for inequality. The stylized model implies that countries with more progressive taxes will have a lower wage inequality.

The authors use a life cycle model where individuals decide each period whether to go to school, work or be unemployed. Human capital accumulation occurs while in school or working. The full model includes a progressive tax on labor income and a flat tax on consumption. Unemployment benefits and retirement systems mimic each country's system. Wage inequality comes from individual differences in ability and idiosyncratic shocks. A conference participant asked whether the tax rates were statutory or effective. Guvenen clarified that they collected information about deductions and credits to get closer to the effective tax rates.

The model is calibrated to U.S. data and applied to the CEU. The main result is that progressive labor income taxes appear to be quantitatively important in explaining wage compression. Progressivity explains half of the difference in overall wage inequality between the U.S .and CEU. The model does particularly well above the median of the wage distribution, explaining 76 percent of the upper end differential. The discussant, Guy Laroque, pointed out that the worst performing bottom half of the wage distribution could be a result of the treatment of minimum wages and benefits. This is evidenced by the fact that the model does particularly poorly in the bottom of the distribution in France, where minimum wage is a substantial institution.

The results for the change in wage dispersion over time show the same pattern of better findings for the distribution above the median. In the U.S., the reduction in progressive taxes alone generates a significant increase in wage inequality.

International Adult Literary Survey data provide a direct measure of human capital that supports the mechanism of the model. Laroque asked to see evidence of the mechanism with data on educational outcomes. The authors' next step is to model free public education in Europe and address differences in the quality of education.

Search Frictions and Wage Dispersion

by Marcus Hagedorn and Iourii Manovskii

Hagedorn and Manovskii use a simple model of on-the-job search to study the impact of search frictions on wage dispersion. Wage regressions that include experience, tenure, match quality, and idiosyncratic productivity can only explain about half of the dispersion in wages observed in the data. Here, the authors focus on differences in match quality across jobs to try to explain more of the observed wage dispersion. To do so, Hagedorn and Manovskii assume that match quality is constant within jobs. The effect from search frictions on wage dispersion is thought to come through different match qualities across jobs. Thus if jobs are very homogenous, search frictions will not be very important in wage dispersion as there is little to gain from search. Using the NLSY79, the authors are able to track the employment and unemployment spells of individuals over a 27 year period. Then, to estimate the impact of the frictions, they find a consistent estimate of the variance of match qualities.

The authors cite two potential problems with this approach, each of which is addressed in turn. First, what if match quality of a job is stochastic instead of being fixed? This would lead to selection effects as jobs with high draws of match quality are more likely to survive than jobs with low draws of match quality. The intuition is as follows: the likelihood of an outside offer is higher in an expan-

sion than in a recession. Therefore, bad matches will end more quickly as there are many other jobs available. However, stochastic match quality can be ruled out because in that scenario match quality would depend positively on the probability of getting an outside job offer. This is not seen in the data. Second, once a labor contract is in place, wages may no longer be dependent on match quality. This could be seen in a contract where the firm consistently matches counteroffers, so the wage would be increasing in the probability of an outside offer. As before, the authors do not find evidence of this in the data.

Participants subsequently discussed the possibility that business cycles affect other aspects of the job in addition to the job finding rate. It was suggested that recessions would increase the variance of match quality as well as transitory productivity shocks. One participant argued that this would make clear predictions much more difficult, as search frictions have two components: productivity shocks and match qualities. However it was shown that the volatility of productivity shocks is zero if there is no selection out of jobs based on the probability of outside offers. Several other issues which might limit this approach were accounted for such as learning about match quality, job-specific wage growth, and Burdett-Coles style equilibrium wage contracts.

The methodology used by Hagedorn and Manovskii focuses on finding residual wages after controlling for the effects of tenure, experience, and differences in individual productivity. The variances of residual wages are then calculated in every year for each person-job pair. Next, the variance in actual wages weighted by the fraction of total observations per job is calculated. The difference between these two is then the variance in match qualities. Using this approach the authors find that search frictions account for about 6% of the variation in wages.

Andreas Hornstein discussed the paper, commenting on a few important points. He suggested that residual wage inequality may not be the best focus to detect the effect of frictions. The frictions could have interactions with other mechanisms that lead to heterogeneity and then it would be much more difficult to determine the individual effect of search frictions. Considering a model with job-specific human capital, both search frictions and the wage-tenure profile play a role in determining the tenure distribution. Since the length of time spent at one job has an important effect on wages with the presence of job-specific human capital, frictions affect wage inequality in a direct and indirect way. One participant stated that given this finding, it would be interesting to know what types of models would be unable to reproduce this and to see which assumptions of those models differed from the one implied here.

The Spending and Debt Response to Minimum Wage Hikes

by Daniel Aaronson, Sumit Agarwal and Eric French

In the data we see increases in spending that are significantly larger than the changes in income after a minimum wage hike. Aaronson et. al. explore these facts and show that models without uncertainty or borrowing constraints cannot account for this. The paper has extensive data work, using the CEX, SIPP, CPS, and credit card data, to examine how spending changes after a minimum wage hike. With a one dollar increase in the minimum wage, a household with one minimum wage worker sees an increase in family income of about $300 per quarter. The result is an increase in spending of about $850. The majority of the spending changes come through the purchase of durables, specifically new vehicles. The authors show that there is essentially no effect on spending and income for individuals with an hourly wage at least twice the minimum wage.

The authors regress the change in wages first on income and next on total spending for different subsets of the sample. The model is identified by differences in the minimum wage across states and changes at the federal level over time. This illustrates a spending response of about $850 dollars, with $500 of spending on new vehicles. In addition, the later years of the CEX have information on how durable spending was financed. The data show that the majority of the new durable spending after the minimum wage hike is through loans. In addition, data from a major credit bureau confirms that there are large increases in debt in the months following a minimum wage hike. One participant wondered how the employment situation changed for minimum wage workers after the hike and if, for instance, firms laid off workers since they were now more costly. French responds that for the individuals in the sample it does not appear that employment is affected, rather that firms cut back on hiring for a few months.

The authors develop a model to match the distribution and timing of the spending response. The intuition is that households with minimum wage workers are credit constrained by the amount of collateral (or future earnings) they have. With an increase in the minimum wage, they are able to increase borrowing. The data show there is little response 6-18 months prior to the minimum wage hike, which is evidence for the households being borrowing constrained. This is true even though the policy change is announced during this time. According to the permanent income hypothesis, an increase in spending should occur immediately upon knowledge of the change in the household's future income. In addition, the sizes of

the spending increases are too large for the households to be spreading the additional income across their lifetimes. When asked why the minimum wage hike is not viewed as an increase in permanent income, French replied that for individuals in the SIPP dataset two years after the hike, only 30% are still earning the minimum wage. In addition, inflation will tend to reduce the gain from one particular change in the minimum wage.

Irina Telyukova discussed the paper, praising the careful data work done by the authors. She notes, however that the paper focuses on the intensive margin for purchases, although the extensive margin may be important. Although the estimates by Aaronson et al. suggest that families with $1,500 increase in family income after a $1 minimum wage hike increases durable spending by $700, in reality what is happening is that a few families are purchasing a new vehicle. Telyukova states that the model is a good framework to consider heterogeneous access to credit or collateralized debt across households. If both the extensive and intensive margins can be considered in the model, it can be useful for thinking about policy experiments with minimum wage changes. Participants discussed the significance of the spending on new vehicles, in that it may be an investment good if it changes the employment opportunities available to the worker. It was mentioned that if the workers are credit constrained, when they receive the additional income it must all be used for investment in durables in order to be able to reach further income gains. Then perhaps in the future we would see larger spending responses in the nondurables category.

Career Length: Effects of Curvature of Earnings Profiles, Earnings Shocks and Social Security

by Lars Ljungqvist and Thomas J. Sargent

There has been much debate about whether the use of employment lotteries and complete insurance markets to generate a high labor supply elasticity with indivisible labor is a good representation of the "real world." In their 2006 paper, Ljungqvist and Sargent show that a more believable assumption of divisible time can replace employment lotteries and generate similar results. This paper focuses on how the slope of a wage-experience profile, unexpected earnings shocks, and social security affect the choice of career length for an individual. The main findings are that an individual will choose a longer career length if they have negative unexpected earnings shocks and negative assets at the time of those shocks, the reverse being true if positive assets are held. An individual with positive shocks and positive asset holdings will also choose a longer career length, and the opposite is true if the individual holds negative assets. Also, higher elasticity of earnings to accumulated working time implies an individual will choose to work a higher fraction of their life than an individual with a lower elasticity.

In the model, a worker has preferences over consumption and labor supply, where labor is measured on the extensive margin and generates a disutility. A worker's earnings are a function of the wage and experience, which is measured as the integral over past employment spells until a given date. The interest rate and discount rate are set to zero to create an environment in which an individual smoothes consumption and the worker is indifferent over the part of the lifetime he works. It is assumed the worker chooses to start working at the beginning of his life, making the present value of earnings a function of the fraction of his lifetime spent working and the curvature of the earnings-experience profile. The optimal career length solves the maximization problem, a function of the present value of earnings and the fraction of the worker's lifetime spent working. As a result, an individual with a higher curvature parameter will choose to work longer because the endogenous shadow value of their retirement savings decreases at a slower rate. Assets are introduced in the model to include unexpected earnings shocks. When the curvature of the earnings profile is positive and workers borrow when they are young and repay when they are old, there is some point in time where assets turn from negative to positive. If the worker receives an unexpected earnings shock they will choose their optimal career length based conjointly on whether the earnings shock and assets at the time of the shock were positive or negative. Workers with a negative shock who hold positive assets at the time of the shock will reduce their career length. Alternatively, workers with a negative shock who hold negative assets at the time of the shock will work a larger fraction of their lifetime than they previously would have. A similar model where unanticipated tax changes replace unexpected earnings shocks will generate the same results as long as the tax revenues are not distributed to the workers. A participant asked what would happen if you changed taxes along the way. Ljungqvist stated that he is focusing on the steady state, but it would be relatively simple to compute the transition paths in the future.

Ljungqvist and Sargent also incorporate social security into the model. A worker will be taxed while working up until the official retirement age and will receive benefits based on the time spent working. In this setup, the endogenous career length is at least equal to the retirement age. If the official retirement age is really high a worker will retire before the official retirement age and the reverse if the retirement age is really low. Another

participant asked how much of their results depend on using their specific functional form. Ljungvist stated that they are confident that any balanced growth preferences will give them the same result, and they use balanced growth preferences because these are the most common in the literature.

The discussant, Chris Taber looked at data to motivate the paper that was presented. He took a simple regression of log wage with respect to age. The figure is very similar to the wage-experience profiles in Ljungqvist and Sargent, with one exception, wages around age 60 begin to fall. This curvature may be a problem since the main focus of this paper is on retirement age. Another point Taber brought up was the lack of human capital depreciation in the model. If you add depreciation to the model you would still be indifferent to working solely in the beginning of your life and only at the end; however, you would prefer both of these to taking a vacation in the middle of your life. Overall, Taber agrees that curvature of the earnings profile seems to be important when discussing choice of career length.

Wage Rigidities and Jobless Recoveries

by Robert Shimer

Shimer uses a search model with a reallocational shock to the capital stock and rigid wages to explain observations of the 2008 financial crisis. Output has recovered to the pre-recession level, however unemployment has seen little improvement giving rise to a "jobless recovery." Here the reallocational shock is a onetime, unanticipated increase in the depreciation rate of capital. Capital is destroyed, or the capital in one sector of the economy is rendered unproductive. In models with flexible wages, this would cause the productivity of labor to fall and wages would adjust downward. However, with rigid wages this adjustment does not occur. A participant wondered if this type of shock may not be accurate for this recession. Rather, what happened is we suddenly realized we had too many houses and reduced investment, and so how does this relate to the model. Shimer responds that this is similar to the reallocational shock if we simply think of it as we were investing in the wrong sector so some portion of the capital stock is unproductive.

The model has workers who divide their time between production and recruiting. Then a firm can cut back on production costs simply by reducing the fraction of employees who are recruiting. Shimer compares three versions of the search model to a frictionless labor market. First, the results from the social planner's problem are considered. In a frictionless model, an increase in the depreciation rate causes employment and investment to increase and consumption, output and the marginal product of labor to decrease. With search frictions, the results of the destruction of capital are similar. The direction of the changes are identical to the frictionless model, however employment adjusts more slowly as it takes time to find workers. Here wages decrease since the labor is less productive. Next, Shimer presents the decentralized version of the model and the equilibrium here always solves the social planner's problem. The effects are the same.

Finally, by adding wage rigidities in the model, the firms cannot adjust the wages after the dstruction of capital, as was seen in the previous cases. The current wage is still acceptable, however, to firms and workers, but the level of recruiting intensity will change substantially. When wages cannot adjust for the decrease in labor productivity, the model shows an equal and permanent decrease in capital, employment, output, consumption, and investment. Firms are still employing workers however they reduce the number of employees by reducing recruitment.

When asked about the role of government in the model, Shimer states that we can think about the decisions of the government sector, and in fact it may take actions that make the situation worse. Suppose the government offers a stimulus; rigid wages are the only effect is that private investment is crowded out.

Rudi Bachmann discussed the paper first by describing the general mechanism that is at work in the model. As opposed to flexible wage models where the labor supply determines the size of the economy, with rigid wages the economy is scaled down with a reduction in capital. Three issues are mentioned: the volatility in investment generated by the model, the functional form of the production function, and the length of time the wage remains constant. Without the depreciation shocks being persistent, the model is unable to generate the size of the change in investment seen in the data. If there are decreasing returns to scale rather than constant returns, we can improve the model's movement in investment. In addition, adding adjustment costs for capital will help with the large, negative change seen in the data. The wage in the model stays fixed for about ten years, and other studies have shown that wages are not necessarily as rigid as the data seems to indicate. A participant asked if the results from the model imply that after the destruction of capital the firm size will shrink and employment immediately adjusts. Shimer responded that in this model, the only changes in employment come through a lack of hiring, not firing of workers since labor productivity is not moving very much.

On the Dynamics of Wage Distributions and Unemployment Volatility: Labour Market Dynamics with Sequential Auctions and Heterogeneous Workers

by Jean-Marc Robin

Several papers in the labor literature show that wage and earnings inequality are countercyclical and have become relatively more pro-cyclical at lower wages and earnings. The data differs from the research in that the tails of the wage distribution are much more pro-cyclical than the middle of the distribution. Other papers in the literature, specifically Shimer (2005), try to solve the unemployment volatility puzzle. Shimer and Hall propose rigid wages as an explanation to the strong pro-cyclic nature of unemployment and why unemployment volatility is higher than the volatility in productivity. The facts above offer motivation for a theory of labor markets that can capture all of these features.

In his paper, Jean-Marc Robin constructs a model that includes aggregate shocks, worker heterogeneity in ability, and idiosyncratic shocks to study wage dynamics, unemployment, and the dynamics of cross-sectional wage distributions. There are a fixed number of worker ability types and fixed number of workers in each type. A worker is born with a given ability and that ability is time invariant. In this model, firms are identical, which implies output is dependent only on worker type and technology. Firms and workers form matches at the beginning of a period after the shock is realized and that match generates a surplus. A match is only viable if the surplus it generates is positive. A negative surplus results in endogenous unemployment. Exogenous unemployment occurs to a fraction of workers with a positive surplus. Meeting rates exist in this model, but are exogenous and there are separate arrival rates for employed and unemployed workers. A key feature of this model is the unemployment rate does not depend on how firms and workers split the surplus; therefore, wage rigidity cannot be a possible explanation for unemployment volatility. Employers have full monopsony power with respect to workers and pay an unemployed worker their reservation wage. Once a worker is employed the wage contract is long-term and can only be renegotiated if both parties agree. On the job search creates Bertrand competition and renegotiation requires the productivity shock to push a worker's current wage outside of the bargaining set. Standard parameters are set to values accepted in the literature and other parameters are calibrated using data from the BLS, CPS, and JOLTS. The model is then simulated and compared to the data. It correctly predicts relatively more pro-cyclical movement in the tails of the wage distribution due to the idea that only wages on the extremes will ever be renegotiated. Volatility predictions for other parameters are very close to the true value especially for wage quantiles. The prediction for job-to-job transition rates was not close, but Robin explains including a matching function would help to capture this value more accurately. Robin suggests an extension of the model that would include firm heterogeneity. A participant questioned Robin on the importance of heterogeneity in the value of leisure. Robin responded that for unemployment it is not that important; however, in matching the pro-cyclical nature of wages it is very important. To generate this pattern leisure must be indexed by productivity. An individual's reservation wage in good states should be lower than their reservation wage in bad states because his future prospect is much better in a good state.

Bjoern Bruegemann, the discussant for the paper reemphasized the paper's contribution: developing a business-cycle model with heterogeneous workers and identical firms that accounts for the high volatility in unemployment and the pro-cyclical nature of the tails of the wage distribution. Bruegemann suggests that on the job search and sequential auctions don't help drive the results of unemployment volatility, rather the relevant component for this result is the heterogeneity in ability of workers. Unemployment volatility results from either a percentage change in the hazard rate of workers, or differences in baseline value of unemployment. In this model, all of the change comes from the hazard rate since all workers start off with the same frictional unemployment. Bruegmann suggests, and Robin agrees that a nice addition to this model would be to consider different education groups that will have different baseline rates like we see in the data.

Demand Shocks as Productivity Shocks

by Yan Bai, José-Víctor Ríos-Rull and Kjetil Storesletten

In a standard business cycle model, output is equal to a function of capital and labor times a productivity shock. In order to increase output, capital, labor, or productivity needs to change. Capital is relatively fixed in the short run, which narrows the choice between labor and productivity shocks. If the increase in output was a direct effect of a change in labor, decreasing returns to scale implies that as labor increases labor productivity and wages fall. We don't see this result in the data; therefore, movements are a result of productivity shocks. Much research has been done to figure out what exactly accounts for these shocks but findings have been fruitless. In this paper, Yan Bai, José-Víctor Ríos-Rull and Kjetil Storesletten claim these shocks are demand shocks. They develop a

business cycle model using only demand shocks, map it to the United States economy, and quantitatively compare the model to a standard real business cycle model. The model with demand shocks does just as well, if not better than the standard model in explaining the data. A participant commented that demand shocks seem like a rather unattractive name and perhaps something like household production shocks would be a better term. Ríos-Rull agreed, but said the shock is more fundamental, specifically anything that gets firms and consumers to spend less. The growth model is created using a Lucas tree model as a starting off point, with capital investment and labor added. The key feature of this model is that firms do well only when customers show up, which implies both investors and consumers, must put forth effort. The efforts by investors and consumers are not measured in the data, but are represented in the model through search frictions; more effort increases output. Shopping frictions differ between households and firms. Firms can be professional shoppers and have different effectiveness than households. Firms will specialize in either consumption goods or investment goods and have different prices. Households have preferences over consumption, leisure, shopping units, and the Markov state. Consumption is a function of shopping effort, probability of the match, and capacity in a consumption location. The model is calibrated to the data using some standard moments and others calibrated specifically to the model economy. The Frisch elasticity in the model was originally set to .7; however, two presenters gave compelling arguments as to why it should be higher, which resulted in a separate analysis for an elasticity of 1.1. After calibrating the model, two shock processes are estimated using maximum-likelihood and then compared to the data. In comparing the two models, the model with demand shocks seems to do just as well as the RBC model in predicting the movement of consumption and investment. The model fails to account for the high volatility of hours seen in the data. If the Frisch elasticity is set to 1.1, more movement in hours is observed. More shocks are added to the model to attempt a full estimation. The shocks included are true productivity, work, shopping ability of households, and shopping ability of firms. The results indicate that productivity shocks account for less than half of the movement in TFP, or less than a third if using a Frisch elasticity of 1.1.

Gary Hansen, the discussant, expanded on the motivation behind the paper. He mentions how Chari, P. Kehoe and McGrattan (Econometrica 2007) show that 73% of the decline during the post-war period is due to TFP while Kydland and Prescott (1991) find it to be 70%. Both papers show support for including technology shocks in real business cycle models. The reason TFP shocks are so important is they are the right size to account for the fluctuations of output we observe in the data. Also, technology shocks seem to generate the correct co-movements among macro aggregates; however, this is all assuming TFP is exogenous. Endogeneity in TFP may stem from incorrect measurement of inputs because we lack information on the fraction of capital and labor actually utilized. Basu (QJE,1996) and Burnside, and Eichenbaum and Rebelo (NBER Macro Annual, 1995) find once utilization is accounted for little cyclicality of TFP is left to explain. Hansen states this paper makes progress in the literature because it shows that shocks can be put in the model that are unrelated to technology and still account for changes in TFP and the movement of aggregates.

The Propagation of Technology Shocks: Do Goods, Credit and Labor Market Imperfections Matter and How Much?

by Nicolas Petrosky-Nadeau and Etienne Wasmer

How do shocks to productivity propagate to explain fluctuations in aggregate variables? This is one of the central questions in the real business cycle (RBC) literature. In an attempt to provide additional volatility of output, some of the literature incorporates frictions to specific markets. Petrosky-Nadeau and Wasmer introduce market imperfections in the form of search frictions to the credit, labor and goods markets. The authors attempt to find which market is the main source of persistence and amplification of technological shocks.

The model is in discrete time with three agents, banks, entrepreneurs and workers, and three imperfect markets, the credit, labor and goods markets. In the first stage, the credit market, an entrepreneur, needs to find a banker. These two agents search for each other in the credit market with free entry. After matching they continue to the next stage and operate jointly as a firm. In the second stage, the labor market, jobs are created and there is a search for workers. The third stage, a perfect goods market, is production and the search to match with a consumer. Lastly, the product is sold, operating costs are paid and banks are repaid.

The authors focus on the labor market since employment is an endogenous state variable, a major input for production and quantitatively relevant. The use of labor search models within RBC has partially resolved the issue of persistence, but relies on a large elasticity of the vacancy-unemployment ratio to productivity. Labor market frictions alone do not explain the persistence of the growth rate of labor market tightness found in the data.

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Hui Chen – *University of Mississippi*

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Simon Gilchrist – *Boston University*

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Thomas Tallarini – *Federal Reserve Board of Governors*

Jules van Binsbergen – *Duke University-Kellogg School of Management and Stanford*

Adrien Verdelhan – *MIT-Sloan*

Lu Zhang – *University of Michigan-Stephen M. Ross School of Business*

Stanley Zin – *New York University*

Summaries of each of the presentations follow. Note: speakers are highlighted in author listings.

Innovation Growth and Asset Pricing
Howard Kung and **Lukas Schmid**
Discussant: Thomas Tallarini

Dividend Strips and the Term-Structure of Growth
Jules van Binsbergen and Ralph Koijen
Discussant: Adlai Fisher

Credit Shocks and Aggregate Fluctuations in an Economy with Production Heterogeneity
Aukhik Khan and Julia Thomas
Discussant: Gian Luca Clementi

Credit Spreads and Business Cycle Fluctuations
Simon Gilchrist and Egon Zakrajsek
Discussant: Lu Zhang

Liquidity and Asset Market Dynamics
Guillaume Rocheteau and Randall Wright
Discussant: Benjamin Lester

Bubbly Liquidity
Emmanuel Fahri and Jean Tirole
Discussant: Adriano Rampini

Growth Opportunities, Technology Shocks and Asset Prices
Leonid Kogan and **Dimitris Papanikolaou**
Discussant: Jesus Fernandez-Villaverde

Rare Disasters and Risk Sharing with Heterogeneous Beliefs
Hui Chen, Scott Joslin and Ngoc-Khanh Tran
Discussant: Rajnish Mehra

International Risk Cycles
Francois Gourio, Michael Siemer and **Adrien Verdelhan**
Discussant: Stan Zin

generally negatively correlated with the investment rate. The authors' model also predicts that the financial frictions lead to large decrease in TFP, which is associated with a decrease in output. Clementi referred to the recent work by Fernald and Matoba (2009), in which the authors show that any measured decrease in TFP during the recent recession is due to mis–measurement of factor inputs. The same authors showed that once one controls for utilization of both capital and labor, TFP is found to increase while investment and output decreased. Nevertheless, Clementi argued that it should be possible to interpret the inefficiency in the Kahn-Thomas paper in terms of utilization, as in Fernald and Matoba (2009). Clementi finally suggested that the cross-sectoral empirical evidence should guide the choice of the borrowing constraints for firms of different types that face different financial conditions. He also suggested investigating the implications on TFP via aggregate shocks to the value of the collateral, which affects the tightness of the borrowing constraint.

Credit Spreads and Business Cycle Fluctuations

by Simon Gilchrist and Egon Zakrajsek

During the period of great financial turmoil that plagued the United States between the summer of 2007 and the spring of 2009, the difference in yields between various private debt instruments and government securities of comparable maturity – credit spreads – served as a gauge of the degree of strain in the financial system. Fluctuations in credit spreads were thought to contain important information regarding the evolution of the real economy and risks to the economic outlook. Gilchrist and Zakrajsek re-examine the evidence on the relationship between credit spreads and economic activity by constructing a new credit spread index, and using it to forecast the real economy. The authors' results suggest that a substantial portion of the predictive content of credit spreads for economic activity is due to the excess bond premium – the deviations in the pricing of corporate bonds relative to the expected default risk of the issuer. Results from a vector autoregression show that shocks to the excess bond premium that are orthogonal to the current state of the economy, the Treasury term structure, and stock returns cause significant declines in consumption, investment, and output as well as in equity prices. These findings are consistent with the notion that an increase in the excess bond premium reflects a reduction in the financial sector's willingness to take risk, and consequently a contraction in the supply of credit, which negatively affects the aggregate economy.

Gilchrist and Zakrajsek focus on credit spreads because of their informational content about the financial position of both the lenders and the borrowers. First, the finance literature has argued that there may be important linkages between the quality of borrowers' balance sheets and their access to external finance. Second, movements in credit spreads may also reflect shifts in the effective supply of funds offered by financial intermediaries. In the latter case, a deterioration in the balance sheet of financial intermediaries leads to a reduction in the supply of credit, which causes an increase in the cost of debt finance – the widening of credit spreads – and a subsequent reduction in spending and production. The authors' approach uses an extensive micro-level data set of secondary market prices of outstanding senior unsecured bonds over the 1973–2009 period to construct the GZ credit spread index. They show that its predictive ability for economic activity significantly exceeds that of the widely used default-risk indicators such as the standard Baa-Aaa corporate bond credit spread, and the Paper-Bill spread. Furthermore, the GZ credit spread index significantly outperforms the standard indicators of the state of monetary policy, such as the Treasury yield curve or the real federal funds rate, in predicting the volatile cyclical components of aggregate demand, such as business fixed investment and inventory investment.

Lu Zhang discussed the Gilchrist-Zakrajsek paper, and made two comments. He first addressed using credit spreads to forecast macroeconomic performance. Gilchrist and Zakrajsek argue in favor of their GZ credit spread for forecasting macroeconomic variables such as payroll employment, industrial production, and real GDP as it yields a larger and significant partial correlation that does not switch sign when extending the forecast horizon. This is in contrast to the Baa-Aaa corporate bond credit spread which they show switches sign over different forecast horizons. Zhang pointed to the temporal relations between risk premiums and economic growth, and argued that a sign switch may be interpreted as an interplay between a risk premium and cash flows effect. He referred to the results of his 2010 JFE paper co-authored with Chen in which they show that the correlation between cumulative payroll and a risk premium proxy switches sign at different forecast horizon depending on whether the underlying model featured one-period or two-period time-to-build. He suggested trying longer forecast horizons of up to sixty months instead of one and four quarters in the paper to investigate the above point. Zhang's second comment was the interpretation of the GZ credit spread index as a risk premium proxy. The author decomposes the GZ credit spread index into expected credit spread – the fitted value of a linear regression including default probability and a set of bond-

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