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FROM THE LAB

UC Santa Barbara | Laboratory for Aggregate Economics and Finance

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UC Santa Barbara
Laboratory for Aggregate Economics & Finance

Associate Director's Message

Peter Rupert

This edition of the newsletter highlights conferences LAEF has sponsored or co-sponsored as well as visitors who spent time at the "Lab."

The second annual Macroeconomics and Business CYCLE conference was held May11-14, 2015, at the Upham Hotel in Santa Barbara. The Upham has been our "home away from home" for many conferences at UCSB. It is a very pleasant setting with a nice conference facility, making it simple for participants to hop out of bed straight to the first talk! The conference has a bit of an unusual style in that presentations, typically four, happen from 8:00 am-1:00 pm and the afternoon is free for further discussion, new ideas, or to enjoy the scenery while cycling through Santa Barbara. Moreover, as many will attest, the papers and cycling routes were challenging indeed! This format has received high praise from the conference attendees, as most conferences squeeze in eight or so papers a day for two days, leaving little time to digest or exchange ideas over the course of the day.

We continue our collaboration with the Tepper School of Business at Carnegie-Mellon University, holding the SIXTH joint conference on Advances in Macro-Finance in Santa Barbara on September 18-19, 2015. These joint conferences push the boundaries between Macroeconomics and areas of Finance. This latest conference was organized by Brent Glover and Ariel Zetlin-Jones, both are assistant professors at Tepper. This conference focused on the relationship between asset prices and macroeconomic fundamentals. Where possible, the organizers paired the discussant to the author with different backgrounds — such as a "macro" discussant for a "finance" topic. In addition, more senior colleagues discussed the work of their more junior ones. This pairing fostered the association between the two disciplines.

The global reach of LAEF continues! In December of 2015 LAEF sponsored a conference in Australia, adding a day to the 2nd annual Workshop of the Australasian Macroeconomic Society (WAMS) in Coogee Beach, Sydney, Australia. The conference was organized by Greg Kaplan (Princeton University) and me.

In "Taxing Atlas: Executive Compensation, Firm Size and Their Impact on Optimal Top Income Tax Rates," Antonio Andrés Bellofatto (University of Queensland), Laurence Ales (Tepper School of Business, Carnegie Mellon University) and Jessie Jiaxu Wang (W. P. Carey School of Business, Arizona State University) tackle the issue of taxation of top labor incomes. Evidently, the issue is controversial and continues to be a hot topic in policy circles. The extensive literature surrounding the debate, however, has not provided policy makers with much guidance—the range of proposed tax rates ranges from 0% to 80%. The authors claim that the lack of consensus comes mainly from the lack of agreement on two attributes of highly talented individuals: the magnitude of their behavioral response to taxes and their prevalence in the population. They find that optimal marginal tax rates for high-income earners are in line with those in the U.S. today.

In "The Hartz Reforms, the German Miracle, and the Reallocation Puzzle," Anja Bauer (the Friedrich-Alexander University of Erlangen-Nuremberg and the Institute for Employment Research (IAB) of the German Federal Employment Agency (BA)) and Ian King (University of Queensland and the Theo and Friedl Schoeller Research Center at the Friedrich-Alexander University of Erlangen-Nuremberg) explore the effect labor market reforms (The Hartz Reforms) had in offsetting the effects of the Great Recession.

They find that the reforms offset the unemployment effects of the Great Recession but the Great Recession offset the effects of the Hartz reforms on labor reallocation.

Cathy Zhang presented "Corporate Finance and Monetary Policy" by Guillaume Rocheteau (University of California, Irvine), Randall Wright (University of Wisconsin, Madison; FRB Chicago and FRB Minneapolis) and Cathy Zhang (Purdue University). The authors examine a model where entrepreneurs finance random investment opportunities using trade credit, bank-issued assets, or money. They search for loans in an over-the-counter market where the terms of the contract, including interest rate, loan size, and down payment, are negotiated subject to pledgeability constraints. They show that theory has implications for the cross-sectional distribution of corporate loan sizes and interest rates, pass-through from nominal to real rates, and the transmission of monetary policy, described by either changes in the money growth rate or open market operations.

Sephorah Mangin presented her paper "Unemployment and the Labor Share." She develops a search-theoretic model of the labor market that leads to a simple relationship between unemployment, workers' reservation wage, and the labor share. Simulating the model from 1951-2012, she finds that labor market conditions, specifically unemployment fluctuations and changes in workers' reservation wage, account for much of the variation in the U.S. labor share at an annual frequency.

In "The Price Distribution and Technological Shocks in Markets with Endogenous Search Intensity," Aristotelis Boukouras (University of Leicester, UK) and Yu Zhu (University of Leicester and Bank of Canada) develop a model that relates the search intensity of households for products to the price distribution and wages. Households decide how much time to spend on work and on search for finding better deals in a market where firms charge different prices. Thus, the equilibrium price distribution and the wage depend on the endogenous search intensity and labor supply. Moreover, positive technological shocks, which reduce price posting costs for firms, lead to an increase in labor supply, wages and to the average price, while they lead to a decrease in search effort, consistent with recent empirical findings.

During the fall there was also a lot of activity in terms of visitors. Roman Sustek from Queen Mary University of London visited for a week. Roman is a former student of Finn's from Carnegie Mellon University. Roman was working on a paper with Finn and one with me. The paper with me examines the mechanism underlying New-Keynesian models. We find that what many believe to be the operating framework, namely the Keynesian real interest rate channel, is *not* the mechanism actually at work. A draft of the paper can be found at https://www.dropbox.com/s/ccvns5rpo83trw7/NewKeynesianModels_Draft2.pdf?dl=0. We believe this paper is important as it helps policy-makers better understand how monetary policy affects the real economy. The paper with Finn, "Mortgages and Monetary Policy," NBER WP 19744, investigates the quantitative impact monetary policy may have on the real economy depending on whether mortgages are fixed-rate or adjustable-rate. It finds, for example, that the transmission mechanism is stronger in the latter case than the former.

Carlos Zarazaga from the Federal Reserve Bank of Dallas visited LAEF for 10 days. The purpose was to make the final revisions of his paper with Finn, "Fiscal Sentiment and the Weak Recovery from the Great Recession: A Quantitative Exploration." This paper will appear in the May 2016 issue of *Journal of Monetary Economics.*

Second Annual Macroeconomics and Business CYCLE

MAY 11-14, 2015

CONFERENCE PARTICIPANTS

Arpad Abraham — European University Institute, Italy
Alejandro Badel — Federal Reserve Bank of St. Louis
R. Anton Braun — Federal Reserve Bank of Atlanta
Thorsten Drautzburg — Federal Reserve Bank of Philadelphia
Lukasz Drozd — University of Pennsylvania - Wharton
Carlos Garriga — Federal Reserve Bank of St. Louis
Aspen Gorry — Utah State University
Finn Kydland — University of California Santa Barbara
Pamela Labadie — George Washington University
Gabriel S. Lee — University of Regensburg, Germany
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Andrea Raffo — Federal Reserve Board of Governors
Peter Rupert — University of California Santa Barbara
Lukas Schmid — Duke University
Hrishikesh Singhania — University of Exeter
Marina Tavares — International Monetary Fund
Marcelo L. Veracierto — Federal Reserve Bank of Chicago
Stephane Verani — Federal Reserve Board of Governors
Ping Wang — Washington University, St. Louis and NBER

Participants and attendees shown at The Upham Hotel in Santa Barbara, California

Accounting for the Sources of Macroeconomic Tail Risks

Enghin Atalay and **Thorsten Drautzburg**

Aggregate activity exhibits tail risks; the distribution of aggregate fluctuations displays both negative skew and fatter tails than that of a normally distributed random variable. Barro (2009) argues that higher-order moments of aggregate activity are critical in assessing the utility cost of macroeconomic fluctuations. Using an accounting framework, the authors present preliminary results of two decompositions of the tail risk. The main contribution is to empirically investigate whether higher moments, skewness, and kurtosis have origins in particular economic sectors (i.e., whether independent sector-specific shocks account for aggregate tail risks).

Atalay and Drautzburg's presentation included two parts: statistical and structural decomposition. The authors looked into the Hodrick-Prescott filtered data of employment for 18 US industries, including non-farm industry data from Bureau of Labor Statistics (BLS) and agricultural data from Bureau of Economic Analysis (BEA), from 1947 to 2014.

In statistical decomposition, the authors considered decomposing skewness and kurtosis of the distribution of aggregate employment growth into corresponding sector-specific moments. The idea behind the decomposition is best explained by an analogy with a variance decomposition: in the presence of non-zero covariance terms, a variance decomposition is exact only if it includes covariance terms. To examine the importance of correlation of industries' employment growth the researchers compared two measures of decomposition with, and without industry employment growth correlation. The major finding is that the three industries contributing most to aggregate tail risks are durable goods, non-durable goods, and the construction sector. The most pronounced difference among two measures is observed for the durable goods industry, pointing to an important correlation between the industries employment growth rates. This motivates the structural decomposition and a model with delicate characterization of input-output (IO) linkage.

Following Foerster, Sarte, and Watson (2011), Atalay and Drautzburg extended the model to allow for consumer durables. In the economy, a representative consumer supplies labor and consumes outputs produced by N competitive industries. The production technology is Cobb-Douglas, with capital, labor, and intermediate goods as inputs. The industry-specific log-productivity is assumed to follow a random walk. In the preliminary result, the authors presented the equilibrium without consumer durables, which is a simple multi sector version of the standard RBC-model. By assuming the economy is on the balanced growth path, the productivity for each sector at each period is backed out from the data.

Atalay and Drautzburg then calibrated the parameters using industry-level information from BEA and compared the model-implied employment based on filtered productivity shocks with actual employment fluctuation. The model turns out to do a good job at replicating aggregate employment dynamics; the correlation is 0.97.

The authors further investigated the determinants of aggregate skewness and kurtosis in the model. First, they examined whether the sectoral productivities are independent; the visualized IO linkage in the heat maps clearly indicated that shocks within the secondary and tertiary sectors tend to be positively correlated, but negatively correlated with industries outside their own broad sector. The strongest linkages are between construction; the correlation is quantitatively significant in accounting for the tail risk. Second, the authors decomposed the aggregate employment tail risk that is due to productivity shocks from each industry, using a similar trick in statistical decomposition. They found that the model-implied skewness and kurtosis overstate that in the data when allowing for cross-sectional dependence. Four sectors — construction, durable goods, state and local government, and finance, insurance and real estate (FIRE)— are found key for explaining aggregate skewness and kurtosis.

A participant was curious whether a common productivity shock, instead of an idiosyncratic shock, can be identified and play an important role in employment dynamics. The authors agreed with him on the importance of common shocks. They attempted to define the aggregate shock as the time fixed effects of the industry-specific productivity shocks. This can be easily implemented since only the accounting is changed, rather than aggregate implications. Another participant asked the presenters whether they looked into the dynamics of output prices in the data. They authors said their current decomposition excluded price data. However, it would be interesting to use information on prices to discipline the model and to distinguish shocks to demand from preference shocks. ◆

On Modeling Risk Shocks

Victor Dorofeenko, **Gabriel S. Lee** and Kevin D. Salyer

Time varying uncertainty—risk shocks — have become popular in recent macroeconomics research. While literature on risk shocks explores different propagation mechanisms, a common theme is that a risk shock is described as a second moment shock. The authors presented a richer characterization of risk by introducing heterogeneous firms. They found that not only the second moment, but also higher moments — skewness and kurtosis — play an important role in explaining the quantitative effects of risk shocks, and further impulse mechanisms for the business cycles.

Based on their previous work, the researchers extended the standard RBC model by adding a Carlstrom-Fuerst style

sector that transforms investment into capital with random technology shock. The capital production sector, owned by risk neutral entrepreneurs, is financed via net worth and loans from the banking sector. With high technology shock, the capital producing firm pays the loan back; whereas, with low shock, the firm declared bankruptcy and the production is taken over by the financial intermediary at the expense of an agency cost.

The core of their model features heterogeneous entrepreneurs with different second moment shocks. The bigger the second moment, the riskier a type is. Since the probability of being a risky type is random, the model produces time-varying shocks. The authors further assumed that entrepreneurs observe the fraction of the risky type, but they do not know their type. It implies the relevant density function is a mixture of two normal distributions. The appealing feature of the mixture is a distribution with bigger kurtosis and skewness than implied by normality. Even if linearization technique is used to solve the model, higher moments continue to influence the economy through their role in determining lending activities. The authors think this an attractive feature of the model.

The objective of an entrepreneur is to maximize the return by choosing the optimal contract subject to the lender's willingness to participate. With the zero-profit condition in a competitive economy, the loss of output due to agency cost implies that the price of capital must exhibit a markup over factor costs. The markup, thus, measures the cost of default (i.e., the credit market frictions). When agency cost is absent, the price of capital in the standard models is restored.

Using linearization to solve equilibrium, and calibrating the Carlstrom-Fuerst agency cost model of business cycles, the paper finds that time varying uncertainty leads to a countercyclical bankruptcy rate, a result consistent with the US data, but opposite to Carlstrom and Fuerst (1997). Moreover, the impact of a small change in the fraction of risk type is quantitatively larger than that of an aggregate shock for the risk premium and bankruptcy rate in the standard models.

One participant asked, about the financial contract, why the entrepreneurs necessarily paid back loans to the banking sector? No penalty was characterized to incentivize the entrepreneurs to fulfill the contract. In other words, there seemed to be no strategic consideration in the economy. The presenters agreed that the financial contract did not characterize strategic interaction and full commitment was assumed in the economy. Using this contract eases the work to capture the role of high order moments and to study the effects of time-varying uncertainty, even after the system of equilibrium conditions was linearized to solve the steady states. ◆

Adverse Selection, Risk Sharing and Business Cycles

Marcelo Veracierto

When considering how to construct dynamic efficient contracts under private information, a risk-neutral principal faces a trade-off between fully insuring the risk-averse agent and incentivizing him to reveal his private information. The principal, therefore, will seek to provide as much insurance as possible while still incentivizing the agent to behave truthfully. Macroeconomists have used this risk-sharing framework to study optimal consumption inequality, optimal unemployment insurance, and taxation. There has been less work devoted to studying the interaction between risk-sharing and business cycles. Veracierto is interested in analyzing how the balance between incentives and risk-sharing should fluctuate over the business cycles. The purpose of this paper is to address this gap in the literature while also presenting a novel computational method for solving mechanism design problems with heterogeneous agents.

Veracierto presented a real business cycle model where the aggregate productivity level follows an AR(1) process. There is a measure one of agents with stochastic lifetimes. These agents can be young or old and when someone dies they are immediately replaced by a newborn. However, there is no sense of intergenerational altruism. Agents value only their own consumption and leisure. The stochastic utility derived from leisure is independent and identically distributed over time. Importantly, an agent's value of leisure is private information. Output is produced using capital and labor with a Cobb-Douglas production function. This output can either be consumed or invested. The resulting mechanism design problem can be written down using a Bellman equation with state variables for the age of the agent, promised value at the beginning of the period, aggregate productivity level, aggregate capital stock, and distribution of old agents across promised values.

In order to solve the mechanism design problem associated with this RBC economy, the author separately characterizes the planning problem for old and young agents. He then presents a general method for computing the business cycle of economies with heterogeneous agents. This involves using spline approximation of decision rules and keeping track of long histories of spline coefficients as state variables. Additionally, a massive number of Monte Carlo simulations are required to linearize the first-order conditions. Veracierto stressed the importance of this methodological contribution.

The results presented were for log-log preferences. This is generally the benchmark case in the macroeconomics literature. With these preferences, Veracierto finds a striking irrelevance result; fluctuations in aggregate variables are identical to those found in the full information case. Veracierto's calibration follows Cooley and Hansen (1993). He presented graphs of response functions using just two values of leisure, low and high. Consumption, leisure, and promised value functions

do not depend on the value of leisure for young or old agents. Additionally, the calibrated model generates impulse response functions for each macro variable that are identical in the public and private information cases. This is visual confirmation of the irrelevance result.

Near the beginning of the presentation, one conference participant asked why the life cycle analysis was necessary. Veracierto explained that in the absence of this agents would go towards "misery." It was also clarified that there is a distribution of promised values across old agents because promised values are a function of each agent's history of consumption and leisure. Conference participants were also interested in how robust these results are to different types of agent's preferences. Veracierto assured the audience that he is working on that, but did not have any results to share at the time of this presentation. ◆

Optimality in an Adverse Selection Insurance Economy with Private Trading

Pamela Labadie

Private information causes friction in trading because it impedes risk-sharing. Implementation of first or second best (incentive efficient) allocations in the model with private information often requires strong restrictions on the structures of markets and the activities of participants. When a model with asymmetric information allows for private trading, it needs even more restrictions to eliminate the arbitrage profit opportunities caused by incentive compatibility constraints. This paper studies the welfare properties of competitive equilibria in an adverse selection insurance model, where some standard restrictions fail to hold, such as separation of markets by types, exclusivity of contracts, and prevention of private-trading arrangements. This paper finds that with the model setting, while the Second Welfare theorem can hold, the First Welfare theorem fails to hold since private trading generates potentially inefficient subsidies across different types of agents. When introducing a market to price the subsidies, and hence restore private-trading constrained efficiency of competitive equilibria, a private-trading constrained efficient version of the First Welfare theorem can hold.

Professor Pamela Labadie started the presentation by introducing the model environment. The basic model is an adverse selection insurance economy.1 It features a single-period pure endowment economy with a consumption good that is tradable and divisible. There is a continuum of agents and two types of agents. Each agents' type is their private information. The endowment of each agent is a discrete random variable that takes two values. The random variable is independently distributed across agents and the realization is public information. When private trading among agents is prohibited and enforced, the social planner determines the state-contingent consumption of all agents and is able to implement an incentive-efficient allocation (second-best allocation). To decentralize an incentive-efficient allocation requires separation of markets by type, prohibition of private trading and exclusivity of contracts. In this case, not all competitive equilibria are incentive efficient, which implies that the First Welfare theorem might not hold. However, a constrained version of the Second Welfare theorem does hold, i.e. any incentive-efficient separating allocation can be decentralized as a competitive equilibrium with transfers.

Pamela then introduces private trading into the model setting. She showed that when private trading exists, agents can choose to consume a convex combination of the allocation offered by a social planner by engaging in private trading. In this case, private trading constrained efficient allocations can be decentralized as a competitive equilibrium with transfers, so a constrained version of the Second welfare theorem holds. However, this might result in arbitrage profit opportunities, which prevented it to match the competitive equilibria. That being said, the incentive compatibility constraints generate an externality, in the form of potentially inefficient subsidies across types of agents. The externality problem can be solved by introducing a market: if introducing a market where the externality can be traded, then the constrained efficiency can be restored. Hence, a constrained version of the First Welfare Theorem can hold.

During the discussion, one participant queried when private trading is present, how will the agents' risk-sharing strategies evolve from those that rule out the possibility of private trading. Pamela responded that with private trading, agents can eliminate the endowment risk but choose not to, but by under- or over-insuring, even though full consumption insurance is available. Further, she pointed out that it is because of the under- or over-insuring behavior, a market for a common level of insurance needs to be introduced to restore efficiency.

[1]The adverse selection insurance economy is studied by Rothschild and Stiglitz, Prescott and Townsend, Bisin and Gottardi and Labadie in the literature. ◆

Bank Deposit Insurance: Implications for Portfolios and Equilibrium Valuation of Risky Assets

Stephen F. Leroy and **Hrishikesh Singhania**

Moral hazard associated with deposit insurance leads to an excessive allocation of resources to risky projects. This could lead to higher equilibrium asset prices, and if deposit insurance is financed by the government to taxpayer subsidy of banks' risk-taking behavior. Actuarially fair insurance programs could eliminate this moral hazard problem. However, actuarial fairness is a strong condition which requires bank regulators to accurately measure changes in bank portfolios' riskiness and adjust premia accordingly.

LeRoy and Singhania propose an alternative to actuarially fair deposit insurance which doesn't affect equilibrium asset prices and where the aggregate subsidy (or penalty) from the taxpayer to banks is zero. Having no transfers between taxpayers and banks, or "revenue neutrality," is a much weaker condition than actuarial fairness – it only requires the insurance program

to subsidize some banks and penalize others as long as the aggregate subsidy or penalty is zero.

The authors study revenue-neutral deposit insurance in a general equilibrium setting where banking is competitive. Agents can either turn over assets to commercial banks in exchange for insured deposits, or hold assets in shadow banks outside the commercial banking system. In this environment they show that asset prices are not distorted under revenue-neutral deposit insurance. This is true, despite that deposit insurance under revenue neutrality is not actuarially fair bank by bank, and date by date.

Furthermore, the authors show that their model can reproduce the coexistence of commercial banks and shadow banks (which don't participate in deposit insurance). This coexistence result holds, regardless of whether the insurance program is financed using deposit-based or risky-asset-based premia. However, they show that the final allocation of risky assets depends on how the insurance program is financed. If the program is financed using deposit-based premia, failing commercial banks purchase risky assets from shadow banks. These banks are willing to pay a premium for risky assets since they know they are going to benefit from a transfer upon failure. On the other hand, when premia are based on risky-asset holdings, commercial banks sell their risky assets to shadow banks. This happens because commercial banks with high returns determine that the insurance premium exceeds expected insurance transfers, so they sell the risky asset to shadow banks and avoid the insurance premium.

Their findings can guide government agencies that insure bank deposits if they want to minimize distortions induced by their programs. The authors also suggest that the implementation of such programs matter for the distribution of risky assets in the economy. Further work on the topic is necessary if current proposals examine extending deposit insurance to non-commercial financial institutions, which may be more vulnerable to runs when premia are based on risky asset holdings.

Leroy and Singhania use the "no deposit insurance" scenario as the benchmark. A participant asked why they didn't use the Pareto efficient benchmark instead. Singhania, the presenter, answered that in their linear model all the different deposit insurance alternatives are Pareto equivalent. Hence, they don't have a normative position. He continued saying that the paper focuses solely on the positive implications of deposit insurance and how it affects asset prices and banks' portfolios (both of commercial and shadow banks).

Another conference participant asked whether the data shows that shadow banks hold less risky assets than commercial banks under deposit based premia, as in the model. The presenter responded he does not have the data needed to answer that question, but he would like do a comparison between bank portfolios across countries with different deposit insurance programs. A different participant proposed an alternative empirical study that could shed light on the issue. He mentioned that if commercial and shadow banks differ in the riskiness of their asset portfolio, this difference could be observed in the same country across types of banks. If we see more failures of shadow banks than commercial banks, one explanation is that shadow banks hold riskier asset portfolios. Singhania liked the idea, but mentioned that failures depend on the capital structure of banks. Shadow banks could be all equity financed, so failures might not necessarily imply riskier asset portfolios.

During a discussion about how banks are defined in the model, the presenter described banks as firms that have a capital structure with deposits and equity, but don't perform maturity transformation. On the same line of questioning he defined shadow banks as the same type of firm, except that they are not covered by deposit insurance.

Lastly, a conference participant asked whether an implication of the model is failure contagion across banks. The presenter responded that there is no such thing as cascade effects, where bank failures affect other bank's probability of default. Instead, a bank may affect another by selling its risky assets, but in this case you could think as the bank that purchases the asset as affecting its own default probability. ◆

Self-fulfilling Runs: Evidence from the U.S. Life Insurance Industry

Nathan Foley-Fisher, Borgham Harajabad and **Stephane Verani**

Investor runs are the core issue of financial stability, however theory suggests there are two distinct reasons for runs: changes in fundamentals, and changes in investors' beliefs. If investors withdraw based on their beliefs about the actions of other investors and their actions consequently lead other investors to withdraw, a self-fulfilling run has occurred. Identifying institutions or markets that are vulnerable to such runs is important as they may originate or amplify and accelerate shocks throughout the financial system. However, empirically identifying self-fulfilling runs is difficult as investors make decisions based simultaneously on information about fundamentals and their beliefs about others' actions. Verani and co-authors exploit the contractual structure of Funding Agreement-Backed Securities (FABS) issued by U.S. life insurers to test if shadow banking is vulnerable to self-fulfilling runs.

During the early 2000's, U.S. life insurers started issuing Extendable Funding Agreement-Backed Securities (XFABS) which are put-able FABS where investors can decide whether or not to extend the maturity of their holding on predetermined election dates. If investors choose not to extend the maturity of their holdings XFABS are converted into short-term maturity securities or bullet bonds. At the beginning of the third quarter of 2007, investors converted holdings worth about $15 million in a market worth over $23 million, Verani and co-authors exploit variation in the

predetermined election dates to test if this run had a self-fulfilling component.

Verani first presented a model of XFABS with a continuum of investors. Each investor is endowed with one unit of an XFABS which pays a coupon on predetermined dates, $t, t+1, \ldots, \bar{t}$. On these dates the investor can choose to convert a fraction or all of his security into a spin-off bullet bond that pays face value at time $t+m$. Investors could receive shocks at any time which induces them to exercise the option of converting their XFABS. The ability of the issuer to make payment at time t is determined by a set of fundamentals, N_t, which depends on the issuer's revenue stream and total payments due at time t. Verani and co-authors prove that if enough investors have election dates between t and $t+1$, there exists a self-fulfilling run if, and only if, payments directly affect the issuer's liquidity. Intuitively, if an investor believes that other investors will withdraw before his next election date, the expected payoff to converting now is unchanged, but the expected payoff to extending the security has decrease. If this decrease is large enough, the investor will withdraw now which has a negative effect on the future liquidity of the issuer. This decrease in future liquidity will cause future investors to withdraw; verifying the investor's original belief, and thus causing a self-fulfilling run.

Verani and co-authors use a reduced form approach to test if an investor's expectations over other investors' actions between his election dates affects his decision to withdraw. The data used comes from 32 life insurers with a total of 65 XFABS and 117 spin-offs. The fundamental identification problem arises since only the fraction of XFABS converted between a security's predetermined dates is observable. This value may contain information about investor's expectations about the amount of XFABS converted and fundamentals that affect an investor's decision to convert. The authors use an instrumental variables approach to isolate the effect of investor's expectations. The instrument proposed is the number of securities that could be converted, as determined by the number of securities with election dates between two election dates of a specific security. This value is the upper bound for the observed number of securities and therefore correlated with the number of observed securities converted. The authors argue that removing changes in the instrument three months leading up to each election date removes innovations that might arise from conversions or new issues during the run period, thus insuring that the instrument is uncorrelated with fundamentals. Using the purged instrument the authors find that a 30 percentage point increase in the XFABS conversion rate between t and $t+1$ predicted by investors at election date t increases the probability that investors convert their XFABS at time t by 64 percentage points. This estimate is statistically significant at the one percent level and robust to specification. With these results the authors conclude that the run on U.S. life insurers' XFABS, which began in the third quarter of 2007, had a self-fulfilling component.

A conference participant asked if the run was from the money market funds that purchased the XFABS, or from a run from the investors of the money market funds. Verani explained that the shock that is modeled and estimated is the run from the money market funds and added that both types of shocks are important for understanding the run on XFABS. Another audience member asked what type of investment decision on XFABS we should see in normal times. Verani answered that every investor should extend their holdings in normal times and showed a graph to verify that this was the case. The graph shows that before the third quarter of 2007 no XFABS were converted. Some conference members took issue with the validity of the results as they rely on investors knowing the number of XFABS that were converted between their election periods. Verani argued that the investors in XFABS were large and therefore, it is reasonable to assume they had access to such information. ◆

Sticky Leverage

Joao Gomes, Urban Jermann and **Lukas Schmid**

In many macroeconomic models, money and inflation have no effect on real variables. To generate monetary non-neutrality, models generally have to include ad-hoc assumptions like sticky prices, money in the utility function, or cash-in-advance constraints. "Sticky Leverage" by Gomes, Jermann, and Schmid tries to generate monetary non-neutrality using the interplay between nominal long-term corporate debt, inflation, and real aggregates. They focus on long-term corporate bonds because this is a ten trillion dollar market in the U.S. and nearly all of these debt contracts are nominal. Inflation can affect the real value of this debt by changing the default risk and investment decisions for firms. This paper demonstrates this mechanism in a fairly simple RBC model.

Gomes, Jermann, and Schmid start with an RBC model that has no frictions and then add in a financial sector. Firms are funded with equity issues and long-term nominal debt, where funding with debt can be beneficial because it has tax advantages, but there is an adjustment cost to changing the level of outstanding debt. A simplifying assumption the authors make is that long-term debt is amortized at a constant rate. This allows them to avoid tracking the maturity of debt contracts and instead track only the total level of outstanding debt.

In their model, there is a continuum of firms that each have a constant returns to scale production function. Each firm faces idiosyncratic i.i.d. shocks which effect after-tax operational profits. There is a reservation value of the shock, which depends on the aggregate state, and firms that draw a shock worse than the reservation value default. The price of debt issuance is determined endogenously and internalizes this default risk.

The key assumptions that make the distribution of firms easy to manage is constant returns to scale and i.i.d. shocks. With these two assumptions, the distribution is degenerate between periods. Firms that default are restructured, incur a

default cost, and then will go on looking like other firms. A key parameter of the model, lambda, pins down how much of the debt principal is repaid each period. If this parameter is equal to one, then the debt resembles one-period debt. In the calibration, this parameter value is set to 0.05, which means bonds have an average maturity of five years.

To show how the model works, the authors show the first order condition for the firm's debt decision. With one-period debt, no resource cost of default, and i.i.d. inflation changes the model generates monetary neutrality, meaning inflation has no impact on the firm's decision. With long-term debt, inflation reduces the value of outstanding debt. The first order condition shows that this increases the amount of debt that firms will want to acquire.

The authors quantitatively evaluate how monetary policy can help stabilize output in response to inflation shocks. As a benchmark, they start with having an exogenous inflation rule and then compare the model dynamics to a model with endogenous inflation resulting from a Taylor rule. With an exogenous inflation rule, an unanticipated drop in inflation raises the real value of debt, which immediately increases default rates and lowers output. It also raises expected future defaults, which makes it difficult for firms to reduce their debt claims since debt claims are less attractive. This leads to sticky leverage that stays too high over a prolonged period of time. This lowers future output and employment, and significantly reduces investment on impact.

With a Taylor rule, they run two separate experiments to study its effectiveness. The first experiment tracks the model dynamics following a low productivity shock. The second tracks the model dynamics following a wealth shock, where a fraction of capital is instantaneously destroyed. For both experiments, the Taylor rule implies a significant increase in inflation following the shock. This leads to smaller fluctuations in output than if risk-free rates were not adjusted according to a Taylor rule, but the effectiveness of the Taylor rule for the other variables besides output is mixed between the two experiments.

The audience had several questions about why debt contracts are nominal. If nominal debt contracts cause so many problems, why isn't debt indexed to inflation? Lukas Schmid replied that his model is focusing on unanticipated inflation shocks which might be rare events, especially deflation events, and no one wants to bear that risk. Other conference participants noted that TIPS, a form of debt that is indexed to inflation, do a bad job of insuring against inflation risk. Conference participants also asked whether this model is applicable to household debt. Lukas Schmid noted that this model could be applicable to that too, most likely to mortgage debt, but their paper focuses only on corporate debt. ◆

Technology Assimilation and Aggregate Productivity

Ping Wang, Tsz-Nga Wong and Chong K. Yip

This paper revisits an old issue of economic development regarding "barriers to rich" for less developed countries: an unusually large TFP gap is required to account for the increasingly widened income disparity between the United States and poor countries. This paper provides a new channel through the country-specific assimilation of a global technology. The central idea is that in a less-developed country, the technology assimilation under limited production techniques and flexibility can prohibit technologies to flow from developed countries, leading to large TFP gaps. Further, this paper shows that the lack of assimilation of the advanced technology can be important in differentiation between trapped and miracle economies. In particular, on the one hand, positive assimilation can contribute to about 40-70% of the rapid growth experience in miracle countries; on the other hand, backward assimilation can account for over 50% of the negative growth outcome in trapped countries.

Professor Ping Wang started the presentation with an introduction of how to adapt the idea of technology assimilation to the conventional production theory. In particular, he compares their model of technology assimilation with a generalized Lucas with CES aggregate production (Lucas-CES), which combines physical capital and human capital augmented labor inputs using a CES production function, and Basu-Weil (1998) and Acemoglu (2009) (BWA), which features an inappropriate technology adoption that refrain the development of less-developed countries. Ping pointed out the special feature of their model of technology assimilation: in contrast to Lucas-CES and BWA, how to assimilate the advanced technology in a less-developed country and the ability of the country to assimilate the advanced technology plays an important role in accounting for economic development for less-developed countries in their model.

Next, Ping specified the framework of their model of technology assimilation. A specific technique can be fully described by two parameters: the input required by the technique and the output generated by the technique. For a specific country, there exists a set of techniques that fit the country the best among the set of techniques. A production function under technology assimilation is then defined as the output with given not only factor endowment, but also specific techniques. In particular, this production function features both the efficiency and measurability for production with a specific technique. The local knowledge is described as a set of production efficiency and flexibility. Based on local knowledge, local firms can choose the best technique for them to undertake. After the assimilation process, TFP of the local production becomes endogenous, and the TFP wedge parameter can be measured as the productivity differences of the local from the global frontier technology.

At the end, Ping presents the result of development accounting for six groups of countries: OECD countries, Early Birds and Labor Comers among countries with development miracles, trapped economies, Latin American economies and others.[1] The development accounting results show that most development miracles exhibit positive assimilation whereas most trapped economies exhibit negative assimilation. By comparing the MSE of development accounting, Ping shows that their model of technology assimilation outperforms both the Lucas-CES and BWA.

During the discussion, a conference participant questioned that the model only allows for one global technology frontier while in reality, different countries at different development stage might face different targeted technology frontier. Another conference participant raised questions about the role of geographical proximity on the technology assimilation process. Ping agreed with their concerns and responded that the future work will be more tailored to country-specific experiences.

[1] Early birds include Japan and countries with over 4% growth and over 20% relative income in 1980. Later comers include countries with over 4% growth and below 20% relative income in 1980. Trapped economies are countries below 1% growth and below 10% relative income in 1970. ◆

The Effects of Moral Hazard on Wage Inequality in a Frictional Labor Market

Arpad Abraham, Fernando Alvarez-Parraz, and Suzanne Forstner

This paper seeks to contribute to the large literature on why workers with similar characteristics are paid different wages. They argue that performance dependent pay induces additional wage dispersion, as effort as well as idiosyncratic shocks further expands the wage distribution in excess of the wage distribution that resulted in previous search-theoretic models of the labor market. The mechanism is that wages must vary across output realizations in order to incentivize workers to provide effort; thus, idiosyncratic shocks can lead to different wage histories. They show that the presence of moral hazard explains around 10% of residual wage inequality, with that number increasing to more than 30% for the lower half of the wage distribution.

They employ a dynamic model of moral hazard, in which ex ante identical agents face frictional labor markets with idiosyncratic productivity shocks. These agents are risk-averse, are not allowed to save, and receive benefits exogenously when unemployed. While employed, they are able to search on the job for employment at other firms; they also make decisions on effort to exert at the firm during each period. Firms offer contracts to mitigate moral hazard in the form of performance dependent pay. Output from a firm is composed of a match-specific component, as well as a stochastic productivity component that is increasing in expectation in worker's effort. Because firms can only observe output from a job, workers with identical effort choices may receive different wage offers, as the firm must differentiate wages by effort choices.

There are a number of mechanisms for this increase in wage dispersion. First, in the presence of uncertainty associated with performance dependent pay, risk-averse workers required higher compensation for every effort level, which leads to an upward compression of the wage distribution. This leads to lower profit levels for the firm, which compresses the number of wage offered by firms. These two effects lead to a decrease in wage inequality. On the other hand, workers have the option to quit at any point, which means that when they receive low draws from the distribution of match specific productivity, they are unwilling to exert a great deal of effort. This leads to an expansion of the distribution of wage at the low end of the distribution. They choose standard functional forms, and calibrate the 14 parameters and show that they match a set of distributional observations on labor market transitions, wage changes, and cross-sectional wages. They find that while there are a number of factors in the contracting environment that serve to decrease wage dispersion, the increase due to the presence of moral hazard is larger. When comparing the "observable effort" economy with the "moral hazard economy," they find an increase in wage dispersion of 10.8%. They further note that the dispersion between the 95th and 5th percentiles, a common measure in the literature, increases by 28.3%. Further, the "mean-to-min" ratio of wages increases by more than 55%, indicating that the effect of moral hazard is large at the bottom of the wage distribution.

One member of the audience commented that the left tail of the model was very sensitive to the calibration of utility out of the labor market; he noted that a different value could reverse some of the results seen in the paper. Another noted that savings were very relevant here, but weren't modeled, with which Abraham agreed. Finally, one member believed that it seemed as though segmented markets could arise, in which firms know the effort level of the workers. Abraham noted that this was possible to a degree, but would never happen completely in the model. ◆

Firing Costs, Misallocation and Aggregate Productivity

Jose-Maria Da-Rocha, **Marina Mendes Tavares** and Diego Restuccia

The authors explore the effect of firing costs on aggregate productivity through the misallocation of workers across firm size. Firing costs make it expensive for firms to adjust the number of workers employed, so relatively productive small firms are unwilling to hire workers, given the costs associated with firing them. Large unproductive firms remain large because the costs associated with firing workers is high. These two effects serve to distort the sizes of firms across the productivity distribution. In the data, the authors note that firing costs range from 1 month's salary to 5 years of wages, meaning that this effect could be quite large. The authors build and calibrate a model, and find that these frictions explain a

large amount of the differences in total factor productivity across countries.

To explain this phenomenon, the authors use a standard continuous time model in which firms are heterogeneous in total factor productivity; TFP evolves over time in a process that depends upon firm size. This allows firing costs to play a role in determining the distribution of TFP over time. In particular, TFP at small establishments is assumed to drift upwards, while TFP at large establishments is assumed to drift downwards. Thus, increases in TFP are going to be largely determined by the hiring activity of the small firms relative to the hiring activity of the large firms. For tractability, small and large firms are assumed to have a fixed number of workers. Over time, large firms have the option to change their designation to being a small firm, by firing a number of workers. They are assumed to pay a linear cost for each worker they fire (their "firing cost"). Herein lies the mechanism: as productivity at large firms decreases, they would like to scale down their operation and become a small firm. However, there are large costs associated with decreasing the size of their workforce. Thus, these firms wait until their productivity is so low that they necessarily must shrink their workforce. For productive small firms, hiring additional workers is an attractive option; however, because the costs associated with firing are large, and there is the possibility to receive a negative TFP shock in the future, these firms wait until their TFP is high enough to justify the possibility of having to fire workers in the future. Combined, these effects serve to misallocate workers towards unproductive large firms, when they should be employed at productive small firms.

They calibrate the model using data from the United States. Unlike many other countries, the US does not have firing costs; thus, their goal is to assess the impact upon US TFP if firing costs were imposed on firms. They assess the impact on aggregates using firing costs ranging from a month to 5 years' worth of wages. When firing costs are equal to a month's wages, TFP declines by about 20 percent, with wages declining by about 6.5 percent. When they change firing costs to 5 years' of wages, TFP falls by more than 80 percent, with wages declining by just under 65 percent. They also note that these policies negatively impact indicators of labor market health, including job turnover. The takeaway is that even small firing costs may be important in determining the difference in TFP across countries, and that large firing costs may be crippling to an economy.

One member of the audience noted that if workers were heterogeneous, firing costs might actually increase TFP. A number of the audience took issue with the lack of firm exit in the model, but Mendes Tavares suggested that firm exit would not tangibly change the results. Another suggested that the same results could be achieved with a model in which old firms exit, but have the same growth rate. Mendes Tavares said that the authors would explore this in the future. ◆

What Do Data on Millions of U.S. Workers Reveal about Life-Cycle Earnings Risk?

Fatih Guvenen, Fatih Karahan, **Serdar Ozkan**, and Jae Song

Recent advances in the availability of U.S. administrative data has allowed economists to take a much deeper look at income risk in the United States. The standard assumption applied in much of the previous literature is that individuals have a lognormal income process. This assumption implies that income shocks by nature have a small kurtosis, specifically a kurtosis of 3.0. However, this new data shows that income shocks have a much larger kurtosis, around 11.73 on average, which means that macroeconomic models should be adjusted to reflect that most income shocks are very small, but a few are very big.

This paper by Fatih Guvenen, Fatih Karahan, Serdar Ozkan, and Jae Song digs into social security administrative data which has earnings records for five million individuals. This data tracks labor income using W-2 forms for workers. This data has no survey response error, no sample attrition, and no top-coding. The main draw backs are the lack of self-employed workers and the lack of hours worked data. There is also a potential concern about under-reporting incomes to avoid taxes.

The authors focus their empirical work on U.S. males between 1978 to 2010, and aged 25 to 60. With such a large sample size, they are able to study higher order moments besides the typical first and second moments looked at in much of the literature. They start by looking at the second moment, the variance of income shocks. They find that across all age groups there is a consistent pattern of low income workers face the largest variance of income shocks, this variance decreases monotonically as workers increase their income percentile, and then there is a spike up in the income variance among the very top income percentiles.

The authors next turn to describing trends in skewness across the income distribution conditional on age group. The skewness of the income shock distribution measures whether income shocks are more likely to be positive or negative. For all age groups and income percentiles, the distribution of income shocks is negatively skewed. Among all age groups, the lowest income percentile has the skewness closest to zero and the skewness becomes more negative as income percentile increases, except for workers at the top of the income distribution. As age increases, the skewness becomes more and more negative, suggesting older workers have larger negative shocks.

The fourth moment, kurtosis, measures whether the income shock distribution has a taller peak around the mean of the distribution and how far out the tails extend. That is, how likely are shocks near the mean and how likely are shocks far from the mean? The authors find that for every age group and

income percentile, the distribution's kurtosis is larger than the kurtosis suggested by a lognormal distribution. Kurtosis for all age groups tends to be increasing in income percentile, except for workers at the very top of the distribution, for whom kurtosis begins to decline. They also find that kurtosis is increasing in age, meaning older workers have a larger chance of getting a very large negative shock, but on average income shocks are closer to the mean of the distribution than for younger workers.

The authors then turn focus to looking at the short- and long-run dynamics of income growth. To do this, they group workers based on log point income changes at a particular point in time and then track how incomes evolve over the following ten year period. If income declines by 50 log points, and then the following year increase by 50 log points, then the original income decline was a purely transitory shock. If incomes stay constant following the 50 log point decline, then the shock was permanent. The data shows that large income shocks tend to be quite transitory, especially negative shocks, while small shocks are much more permanent, especially small positive shocks.

The last question the authors try to address using this data is how much does lifetime income grow for workers in different percentiles of the lifetime income distribution. They find that the median worker sees a 38% increase in income from age 25 to 55. By contrast, the top 1 percentile sees a 15-fold increase in income and workers below the 19th percentile actually see an income decline over their life.

To conclude the talk, Serdar Ozkan provides a set of parameter values that should be used in calibrated models with income shock processes. These target parameter values more accurately reflect the type of income risk that has been found using the SSA data compared to what has been used in the past with the lognormality assumption. The authors of this paper intend to construct Markov transition matrices that summarize these processes so future calibrated models can more accurately reflect the type of income risk individuals face.

The discussion for this paper focused on trying to better understand the data. Some conference participants were curious whether the commonly used Panel Study of Income Dynamics (PSID) would show the same third and fourth order moment statistics as the SSA data. The presenter noted that many of the statistics presented in this paper cannot be generated in the PSID because the PSID does not have enough observations. There was also some discussion about whether the increased left skewness for older workers was driven by predictable retirement decisions or more random job loss. This is something that can be explored using this data, but has not yet been looked at. ◆

Firing Costs and Labor Market Fluctuations: A Cross-Country Analysis

Gonzalo Llosa, Lee Ohanian, **Andrea Raffo** and Richard Rogerson

Using cross-country data on quarterly employment, hours per worker and total hours, Llosa, Ohanian and Raffo derive three empirical facts regarding cross-country differences in business cycle fluctuations in the labor market. First, there are large differences in the volatility of hours per worker (intensive margin) and employment (extensive margin) relative to the volatility of output during the business cycle. Second, there exists a positive correlation between the volatility of employment relative to output and the volatility of total hours relative to output. Third, countries with larger fluctuations in employment relative to hours per worker also have employment fluctuations that have a higher correlation with output. Llosa, Ohanian and Raffo investigate to what extent differences in labor market policies, specifically firing costs, across countries can account for these facts. Intuitively, increasing firing costs would be expected to lead to more fluctuations along the intensive margin and less along the extensive margin, all else equal. Raffo motivated the exercise by showing a graph of volatility of hours per worker relative to volatility of employment against the volatility of total hours worked relative to volatility of output using data from 14 OECD countries. The graph shows a clear negative correlation, implying that countries that adjust more along the extensive margin tend to display higher volatility in aggregate hours.

The authors use a standard neoclassical growth model extended to include labor supply decisions along both the intensive, and extensive margins. The utility function thus has two labor supply elasticities. Aggregate production is Cobb-Douglas with a multiplicative productivity shock that follows an AR(1) process in logs. The costs associated with firing workers is subtracted from aggregate output with a fixed marginal cost, thus the losses associated with adjusting along the extensive margin are associated with output losses. Raffo and co-authors use two different calibrations to investigate the extent that firing cost can account for differences in the volatility of hours per worker relative to the volatility of employment. Both calibrations choose the discount rate, the Cobb-Douglas parameter, the depreciation rate and two constants of the utility function to match capital's share of income, the investment to output ratio, the steady state interest rate and the levels of employment and hours per worker for the US data. The elasticity of labor supply along the extensive margin is set to 0.5 and the elasticity of labor supply along the intensive margin chosen to match the volatility of employment relative to hours per worker. The first calibration chooses firing costs to be zero (i.e. assuming the US has no adjustment cots) and the second calibration chooses firing costs to be 4.5 percent of quarterly wages, which are interpreted as technology costs associated with adjustment.

Under the first set of calibrated parameters, Raffo and co-authors increase the firing cots from zero to two quarters of

wages, and analyze how the ratio of the volatility of hours per worker to the volatility of employment changes with the ratio the volatility of total hours to the volatility of output. Although the model delivers a negative correlation as portrayed in the data, the correlation is small relative to the empirical correlation. Additionally, the maximum firing costs needed to fit the data is very small, only 4 percent of quarterly wages. The second calibration delivers a slightly stronger negative correlation than implied by the data. The authors argue that by including a small firing cost for the US, the model can capture the patterns of the data both quantitatively and qualitatively. Under this second calibration the maximum firing cost needed to fit the data is 10% of quarterly wages which is much lower than previously estimated in the literature for OECD countries with strict labor market policies. Raffo and co-authors argue that other estimates from the literature are overestimated since they do not use a model that includes an intensive margin. Intuitively, if the extensive margin is the only margin of adjustment it is used even if it is costly to do so.

A conference participant asked if the changes in the volatility of hours and employment that we see in the data could be caused by structural changes, such as certain industries shrinking or expanding. Raffo agreed that this could be true, but that the paper does not exploit variation over time since all volatilities are averages over time. A member of the audience questioned the simplicity of the model and argued that a representative firm model was not a good way to investigate firing taxes. Raffo argued that it is the simplest way to investigate the quantities and magnitudes of substitution between the intensive and extensive margin. Another conference participant wondered why Raffo and co-authors were using hours paid data, as this data includes part time workers who may not be subject to firing costs. He argued that the firing costs should have two components; one for part time workers, and one for full time workers. Raffo argued that the model is a very conservative version of such a model, and including different costs for part time and full time workers would increase the importance of including an intensive margin in the model, thus helping their argument. ◆

Land Prices and Unemployment

Zheng Liu, Jianjun Miao and Tao Zha

Liu and co-authors document that land prices and unemployment tend to move in opposite directions over the business cycle. Using Bayesian vector autoregressions, they show that a negative shock to the land price leads to a rise in unemployment, and a decline in consumption, investment, total hours, and vacancies. Liu presented a structural analysis of dynamic link between the land price and unemployment by incorporating search frictions and credit constraints into a DSGE framework, and fitting the model to US quarterly time series from 1975 to 2012.

The model consists of households, capitalists, and firms. Households contain a representative continuum of workers, a fraction of which are employed while the other fraction searches for jobs. The utility function is non-separable in land and consumption. Households maximize utility by choosing consumption and investment in the risk free bond market and land. Capitalists derive utility from consuming the final good, and have access to technology that transforms the consumption good into the capital good. The land capitalist owns firms that produce using the capital good and workers. He can finance the acquisition of these inputs using both internal and external funds. Limited contract enforcement limits the capitalist's borrowing capacity by the value of his collateral assets, land, and capital stocks. Firms post vacancies and can only produce if matched with a worker. The aggregate number of matches is determined by a Cobb-Douglas matching function. Once matched, the firm and worker bargain over wages and hours. Liu and co-authors estimate parameters that do not affect the steady state using six US time series: land prices, consumption, investment, labor hours, vacancy rate, and the unemployment rate. The remaining parameters are calibrated and obtained using steady-state restrictions.

The estimated model fits the data well, reproducing similar co-movements of land prices and unemployment, investment, total hours, consumption, and vacancies. The model also generates a volatility ratio, defined as the standard deviation of labor market tightness relative to labor productivity, of 27.47 compared to 24.91 in the data. Liu and co-authors show that land price fluctuations are primarily driving housing demand shock and that such shocks account for a 2.5 percentage point increase in the unemployment rate during the great recession. The importance of the housing shocks arises through two channels: the credit channel and the labor channel. The credit channel works as follows: a negative housing shock decreases land prices and tightens the capitalist's borrow capacity which reduces business investment. Lower investment leads to lower capital stocks in the future, which lowers workers' future marginal product. This decreases the present value of a new match and decreases the number of new vacancies, which in return increase unemployment. The labor market channel exists from endogenous wage rigidities in the model which offset the downward pressure on wages from an increased unemployment duration. These rigidities arise from the non-separable utility: as land prices decline, households' marginal utility of consumption decreases, thereby raising the workers' threat point in the wage bargaining. Liu and co-authors also show the importance of the intensive margin of work in the model by showing that the model with inelastic labor supply overestimates the unemployment dynamics.

A conference participant questioned why Liu was using data on residential land prices when the mechanism in the model relies on firms land holdings, and suggested that data on capital land prices would be more suitable. Liu argued

that the residential housing price co-moves closely with the industrial housing price, and thus, can be considered a close proxy. Several audience members took issue with Liu using housing services and land prices interchangeably. Liu reiterated that the fluctuations in housing prices are primarily driven by changes in land prices, arguing that the relative price of structures is fairly constant. Another audience member stated that structure prices account for one-third of housing prices, and land prices account for the remaining two-thirds of housing prices. He then argued that ignoring one-third of the price may have large impacts on the model. Liu again argued that structure prices do no change much, and that including structure prices would complicate the model greatly, but would not change the underlying mechanism driving the dynamics between land prices and unemployment. ◆

Financial Contracting with Enforcement Externalities

Lukasz A. Drozd and Ricardo Serrano-Padial

In the context of financial contracting, borrowers' limited liability and private information about a project's outcome can lead to moral hazard. In this case, lenders usually spend resources to build enforcement capacity to verify the outcome of projects. Verifying the outcome of reportedly failed projects can preserve their liquidation value and maintain proper incentives.

Drozd and Serrano-Padial consider the role of a principal's enforcement capacity on the incentives agents face when this capacity may be limited by the amount of aggregate defaults. In particular, the authors model the principal as contracting with a population of agents rather than one single individual. Agents face heterogeneous risk on their projects and have limited liability in case their project fails. The principal, on the other hand, can pay a cost to randomly verify the outcome of agents' projects after the realization of the project's returns. However, in order to perform audits the principal must build enforcement capacity ex ante. In some cases, the enforcement capacity of the principal may be constrained since the default rate on loans influences the probability that a defaulting agent will be subject to audits, and thus his incentive to default. The authors refer to this effect as an enforcement externality.

Within this framework the authors examine two questions. The first is how the enforcement externality affects an economy's response to aggregate shocks. A shock that initially raises the aggregate default rate, hence lowering expected state verification probability ex post, adversely affects incentives to default of all agents in the economy. As a consequence, the initial shock is amplified by the constraint, leading to a default contagion episode. In the face of a large default rate and limited capacity to enforce, the principal reacts by extending less credit to agents, leading to a credit crunch in the market for new loans.

This mechanism is measured in their quantitative exercise. They show that credit crunches that follow large shocks feature a contraction of credit of 30 to 50%. The reason for this contraction is that the principal needs to lower credit when enforcement capacity is binding to lower entrepreneurs propensity to default. Otherwise, maintaining credit levels would lead to larger aggregate default rates.

The second question is how enforcement externality affects incentives of developing countries to build enforcement capacity. Their analysis shows that limited enforcement capacity can affect economic growth by increasing the sensitivity of enforcement accumulation to political economy distortions. Because agents cluster around the threshold of the decision to default, small changes to the principal's preference towards her consumption can lead to what the authors call "financial development trap." This state is characterized by a diversion of resources away from investment in enforcement capacity towards the principal's consumption, which results in a lack of lending to entrepreneurs.

A conference participant asked why the size of the loan to agents is not a function of their productivity. Drozd, the presenter, responded that it can't be a function of agents' productivity because the principal can't observe productivity unless she verifies. Instead the principal creates a menu of options for agents comprised of the value of the loan, the repayment amount, and the states (realization of risk) when the agent will be monitored. Agents in turn choose which contract within the menu maximizes their welfare.

Another participant asked whether the enforcement capacity constraint is always binding. The author mentioned that it is not always binding, only under large shocks that occur with low probability.

Another participant noted that financial contracts in the model are state contingent ex post; he wondered whether they are state contingent ex ante. The presenter responded that contracts are state contingent in the sense that enforcement capacity has been already decided when agents make their choices and the uncertainty about the projects' outcomes have been realized. He further mentioned that the contacts would be contingent depending on the projects' outcomes, if the timing of the problem was reversed.

Before the end of the talk Drozd mentioned that in the process of writing the paper, he and Serrano-Padial realized that a different audit strategy would alleviate the enforcement externality problem. They discovered that if the principal would announce the order in which the agents would be audited instead of random audits, the enforcement externality problem would be reduced, although not eliminated. ◆

The Sufficient Statistic Approach: Predicting the Top of the Laffer Curve

Alejandro Badel and Mark Huggett

The sufficient statistics approach seeks to provide policy recommendations using high-level elasticities that summarize taxpayers' responses to changes in tax policy. One application of this approach is to predict the revenue maximizing tax rate of high income taxpayers for some specified component of income or expenditure.

In this paper, Badel and Huggett point out that the widely-used sufficient statistic formula employed to find the top of the Laffer curve (revenue maximizing tax rate) doesn't apply to a wide class of models. In particular, the formula is not valid in dynamic models that form the basis of tax analysis in modern macroeconomics.

To address this concern, the authors develop a sufficient statistic formula that applies to static models and to steady states of dynamic models. In particular, the authors show that their formula applies to the static Mirrleesian model, and can also work in an overlapping generations model and the neo-classical growth model with an infinitely-lived agent.

In addition, the authors validate their formula on two dynamic models with human capital. Their numerical exercises first examine whether their formula can predict the top of the models' Laffer curve. The elasticities and other formula coefficients are computed using the model's data at an initial marginal tax rate point of 42% (corresponding to the top income tax rate in the US). Their formula predicts that the top of the Laffer curve is 52% on the endogenous human capital accumulation model and 64% when human capital accumulation is exogenous. Then the authors change the model's marginal tax rate to find the model's revenue maximizing rate at 52% and 66% for the endogenous and exogenous human capital accumulation models respectively. In contrast, applying the widely-used formula predicts the top of the Laffer curve at 56% and 67%, beyond the revenue maximizing point.

Secondly, the authors use model generated data to compare the true earnings elasticities of top earners to estimates found using state-of-the-art empirical methods. They find that existing methods underestimate the theoretically-relevant elasticity in the endogenous human capital model but overestimate the elasticity in the exogenous human capital model. This leads them to suggest that existing methods don't fully account for taxpayers' human capital responses to tax reform. Their explanation for these discrepancies lies on the response of human capital to changes in tax rates. In the human capital model, agents decrease their investments in human capital over the lifetime in response to the reform, which takes a long time to be fully realized. On the other hand, most of the behavioral changes in labor inputs on the exogenous human capital accumulation model happen up front. Therefore, methods that measure changes in income or labor supply immediately after a tax reform would estimate a small elasticity under the endogenous human capital model and a larger elasticity in the exogenous case.

During the conference a participant asked whether taxpayer subsidies where ruled out in the model by the restriction that marginal taxes had to be positive. Badel, the presenter, responded that the tax functions described in the model can accommodate negative tax liability even when marginal tax rates are non-negative.

Another participant questioned the assumption that agents' types must be exogenous. He commented that ability, for instance, has exogenous and endogenous components. The presenter responded that their formula requires that when you take the derivative of the aggregates (such as income or tax revenues) there is no derivative term of the measure (upon which the aggregates are defined). Their formula can be used as long as models with certain kinds of endogenous agent types can be transformed so that their state variables (aggregates) behave this way.

Participants had clarifying questions about their quantitative exercises. In particular, one asked whether they used a fixed income figure or a percentile to define the threshold that separates high income taxpayers from the rest of the distribution. Badel answered that the cutoff they use corresponds with the top 1% of the US income distribution in 2010. They don't base their cutoffs on percentiles; they use dollar figures which they don't move around. Their formula is consistent with a tax reform where this income threshold is fixed.

In answer to further questions about the tax reform exercise he clarified that their experiment consists of raising the marginal taxes for agents above an income cut off point, and this increase is discontinuous, so they are not moving the tax schedule before the cutoff (in contrast to the alternative, the changing top income tax rate while maintaining continuity in the tax schedule, which will also raise tax rates on those below the income threshold). ◆

The Cost of Uncertainty about the Timing of Social Security Reform

Frank N. Caliendo, **Aspen Gorry** and Sita Slavov

There exists uncertainty about both the timing of Social Security reform, and the structure of reform. Gorry and co-authors analyze the welfare consequences of uncertainty over the timing and structure of a reform using a two stage stochastic optimal control problem. The model is formulated in continuous time, and agents maximize future expected utility of consumption where the period utility function is CRRA. At time zero, agents enter the labor force, supply one unit of time inelastically, pay taxes, and make consumption and saving decisions. At time T, agents retire and receive social security benefits. Gorry and co-authors analyze two cases of uncertainty: uncertainty over the timing of a social security reform, and double uncertainty (i.e., uncertainty over the timing of a reform and the structure of the

reform). In both cases welfare changes are compared to a no-risk environment in which there still exists a social security reform, however, agents know with certainty the structure and timing of the reform. The model is parameterized such that agents enter at age 25, retire at age 65, and discount using a survival function.

First Gorry and co-authors analyze the welfare impacts of uncertainty over the timing of social security benefits using two different structural changes: a full benefit reform in which benefits are cut by 21 percent, and a full tax reform in which taxes increase by 3% over the working period. The authors use a Weibull distribution for the density over reform dates with two calibrations: first, using a constant hazard of reform and calibrating the free parameter to match a 1% change of an individual escaping reform altogether; and second, choosing both the shape and location parameters such that there exists a mass around 2033, the year in which Social Security funds are forecast to run out. Using the first calibration, Gorry and co-authors find that the welfare loss associated with the uncertainty over the time of a reform for the average earning individual is roughly 0.01%. Under both calibrations, very low income individuals, those earning 25% of average wages, experience the largest welfare losses. Intuitively, since benefits are a larger portion of low income individuals total lifetime income, benefit cuts affect them the most. In the alternative reform structure, total tax reform, the highest income earners have the largest welfare losses from the uncertainty of the time of a reform.

Second Gorry and co-authors analyze the welfare impacts of double uncertainty by introducing a density over the structure of the reform. The density is uniformly distributed over full benefit reform, full tax reform and any convex combination of the two. In this case, very low income individuals experience welfare losses 3 times greater than the richest individuals from the uncertainty over the timing and structure of reform. The authors show that although there exists a net welfare loss from a reform, in some cases individuals will increase their consumption after the sock is realized. Intuitively, if a tax reform shock is realized and the individual is close to retirement, he will increase his consumption since in expectation there was a decrease to his future benefits that no longer exist after a tax reform was realized. Gorry concluded by stating that all welfare losses analyzed will disappear as long as policymakers announce when and how Social Security will be reformed.

A conference participant was worried that the full impact of the uncertainty of the timing of a reform is not realized since retirement is exogenous in the model. He suggested that if retirement was endogenous individuals could respond to the realization of the timing shock by changing their retirement age instead of consumption levels. Gorry agreed that individuals' responses other than changes in compunction are important margins to consider in the future. Several audience members were concerned about the size of the tax reform when the timing of the change was uncertain, arguing that a 3% increase in taxes may not cover the deficit depending on when the reform takes place. Gorry agreed that the budget would get worse over time, but argued that this increase would be slow enough, therefore not affecting the results significantly. He stated that an increase in the time of reform of about 50 years would lead to a 0.5 percent increase in taxes. Gorry argued that since labor supply was inelastic this increase in taxes was is small however, stated that in a model with endogenous labor supply the increase in taxes associated with a change in the timing of reform would be more significant. ◆

The Implications of a Graying Japan for Government Policy

R. Anton Braun and Douglas H. Joines

Japan's aging population implies that government expenditures in Japan will continue to grow at a faster rate than before. This paper considers different corrective measures to fix fiscal imbalances: taxes on assets, labor income, and consumption and lower expenditures by higher medical copays for retirees or reduced public pension benefits. The central question of the paper is how much taxes have to rise/expenditures have to decrease for the Japanese government to remain solvent in the years to come.

They consider a computational overlapping generations model in the spirit of Auerbach and Kotlikoff (1987). The only source of uncertainty is life expectancy risk. They use a rich demographic structure that allows detailed calculation of medical expenditure. Looking at Japanese demographic data, they find that the population is asymptotically diminishing. They posit a stable terminal population where fertility recovers between 2060 and 2160. The old-age dependency ratio (working age population to retirees) peaks at 88%.

One participant asks if health is in the utility function. The author responds that it is not, and the medical expenses are shocks. Because they vary with age, the medical expense shocks are effectively a tax on age.

In 2004 Japan legislated a change in the rate of contribution to pensions which will peak to 18.3% of income in 2017. This is partially indexed, but because Japan experienced deflation during some of this time period, the indexing was not particularly valuable. They use data from Fukui and Iwamoto (2006) to forecast medical expenses, and find medical expenses will average $25,000 by age 99. An audience member asked about Japan's medical expenses compared to the United States. The author showed a graph that by 2040, Japan's medical expenses will be roughly at the U.S. level.

The author caveats the discussion of results with the fact that the authors have biased everything in an optimistic way. Even with this optimistic bias, things look grim for Japan.

The authors find that just using lump-sum taxes, Japan would need to raise them by 6%. The consumption tax rate would have to be 26.4% at a debt-GDP ratio of 1. The capital tax rate would

have to be 48% and even with that, it would not be enough. A labor tax would depress output in the long run. This is because a labor tax would need to be very high, because the tax base is very narrow. Higher copays for the elderly (above 75 years of age) would be good for output. An audience member added that yes, it would be good for output, but it would be bad for welfare; the author agreed.

The discussion then moved to female labor force participation in Japan. For workers aged 40-44, the gender wage gap is 38%. In addition, only 55% of women aged 40-44 work full time in Japan. The ratio is even lower for older aged women. The author presented a counterfactual: suppose the gender wage gap was 11% (the wage gap between full-time females and males, aged 20-24), and suppose that the labor force participation rate for Japanese women of all ages was 70%. With a debt-to-GDP ratio of 1, the consumption tax falls from 26.4% to 24.7%. Higher tax revenue is partially offset by higher public pension expenditures.

The author then discusses immigration: there is no formal immigration component in the model. Immigration is captured by assuming a high birth rate of 21 year olds. Using inflows of 200,000 people per year, the authors find the ratio of workers in the total population would rise, and the consumption tax would only need to be 21.9% (from 26.4%). Per capita output would also rise modestly.

The author finally moves to deriving the entire path of output, consumption, government debt, and other macroeconomic variables. The purpose of this analysis is to look at the urgency of the need for fiscal consolidation and how high the taxes would have to be to fix the problem.

The first policy experiment the authors do is not change fiscal expenditures or revenue. Instead, they keep a consumption tax of 8% and cap the debt-GDP ratio at 3.5. The consumption tax would automatically adjust to 55% when the cap is hit. This would lead to a severe fiscal crisis in 2036. The authors conjecture that any resolution would include some form of default on outstanding debt.

Stabilizing the debt-GDP ratio is a short-run priority. The greying of Japan implies that government expenditures for long-term care will continue to grow at very high rates. The authors suggest increasing administrative medical copays for those aged 65+ to 30% between 2021 and 2048. This works differently from cutting pensions: high distortions coming from a labor tax. Increasing copays creates a big demand for savings and leads to higher work effort. The maximum value of the consumption tax becomes 22.8%, and the debt-GDP ratio stabilizes immediately. They compare this to a constant tax scenario, and find a constant tax scenario is preferred to a high copay scenario for those born between 1988 and 2030.

In conclusion, Japan requires significant policy reforms in order to avoid a severe fiscal crisis. The authors' estimate of the amount of time remaining to act should be taken as a loose upper bound on how much time remains to act. ◆

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Participants and attendees shown at The Upham Hotel in Santa Barbara, California

Political Economy of Sovereign Debt: Cycles of Debt Crisis and Inequality Overhang

Alessandro Dovis, Mikhail Golosov **and Ali Shourideh**

Austerity can be a politically difficult policy to implement as evidenced by the European debt crisis. In Greece, Portugal, Spain and other countries, opposing groups held large public demonstrations protesting austerity measures. The back and forth between austerity and social unrest gives way to what Dovis, Golosov, and Shourideh call the "populist policy cycle." The cycle follows three steps: first, the government borrows from abroad to finance higher public spending; second, the government borrows in excess of what their tax revenues can support; finally, the government must reduce public spending and/or restructure their debt to bring it to a manageable level.

The authors examine this cycle in the context of a theoretical model comprised of a continuum of agents who live for two periods. In the first period of life, agents earn income from working. These agents differ in their earning ability, and can borrow/lend to each other to further as needed. Young agents can also receive income in the form of government transfers. Older agents are retired and consume out of savings and a government pension. Transfers and pensions are funded from taxes on labor income and assets. The government can also borrow from abroad to further fund its transfers and pensions.

The government aims to reduce wealth inequality. Each period the government chooses taxes, transfers, and pensions. The government also chooses how much to borrow and whether to restructure existing debt. In a typical model, the government would commit to repaying debt and would choose taxes and transfers to perfectly accomplish its redistributive goals. In this model, however, the government cannot commit to repay debt in the future. Consequently, there are some combinations of wealth inequality and government debt that will lead to optimal debt restricting and austerity. Interestingly, the model suggests that countries with excessive debt will overcorrect their debt adjustment. This allows inequality to increase, giving the government fresh incentives to increase borrowing to keep inequality low. In this way, the populist policy cycle emerges in the model.

A nice feature of this model, as pointed out by one listener, is that the cycle is not the result of a two period overlapping generations set-up as one might initially think. Rather, it is due to a combination of nonlinearities in the government's policy function and incentive compatibility constraints that cause the government to overcorrect its debt position when restructuring. Consequently, the results should be preserved even if the overlapping generations set-up were extended to more periods.

Another listener raised the question of what would happen in this model if the government was allowed to default on its debt obligations. The resulting discussion concluded that although it is not perfectly clear whether or not the model could handle default in place of debt restructuring, the model is more focused on quantities than on changes as opposed to prices, which arguably play a larger role in causing a country to default.

The remaining discussion centered on the observed episodes of the populist policy cycle. Latin America, in particular, was discussed as a region where the populist policy cycle may have appeared historically. In the past 30 years several Latin American countries have had to repeatedly restructure their debt, including Argentina, Mexico, Ecuador, and others. ◆

A Macrofinance View of US Sovereign CDS Premiums

Mikhail Chernov, Lukas Schmid and Andres Schneider

Throughout financial economics, US treasuries are often used as a risk-free asset. If the probability of a US default is actually free of risk, then insurance against US default – issued in the form of credit default swaps (CDS) – should have a premium of zero. This was the case up until the recent financial crisis. Before the financial crisis CDS premiums for US debt were stable around 2 basis points. Since the crisis CDS premiums have been significantly higher. Premiums exceeded 100 basis points near the end of 2008, and have spiked in response to major economic and political events. Near the end of 2014 CDS premiums were above 30 basis points.

In explaining why CDS premiums are suddenly positive, Chernov, Schmid, and Schneider construct a simple macro model in which the government can default on its loans with some small probability. The economy features a representative agent with an exogenous income stream, and a government that collects taxes and issues nominal debt to finance an exogenous series of expenditures. Monetary and fiscal policies are rule based, and the tax rate is determined by the government budget constraint. Taxes decrease future growth such that if debt is high enough, the government may not be able to raise taxes enough to cover their expenses.

The model generates premiums for CDS that match the US data very well for both short and long horizons. The way in which the model generates a positive CDS premium has to do with when default occurs. Since default only occurs when consumption is low (marginal utility is high), those issuing insurance must make payments at an inconvenient time, and in large quantities. To compensate insurers for this risk, CDS premiums are positive and increase with inflation and debt.

Much of the resulting discussion centered on the risks CDS's insure against that require sellers to charge a premium. One possible risk, as suggested by one listener, is that since US CDS's are denominated in Euros, they insure against a weaker dollar in the event of a US default. Listeners also identified several risks related to the legal process in collecting compensation from US CDS's. The first is that defining what constitutes default can be quite difficult. If in the future, the US fails to repay some of its debt on time, a committee of wealth managers (and some CDS sellers) will vote to determine whether the US has defaulted

or not. If the committee votes that a default has occurred, then the amount that is paid out to CDS holders is determined via an auction-type mechanism. Some of the may exist premium to offset the uncertainty surrounding the timing and magnitude of payouts to CDS holders.

The discussion also centered on the model and how it compares with the CDS data. One listener pointed out that the US doesn't actually follow a Taylor rule, so while it is convenient and transparent from a modeling standpoint, the model still does not completely answer why in reality we observe these positive premiums. The model, however, does provide a useful framework for discussing these CDS premiums. Other comments pointed to the possibility of CDS sellers learning about their risks/opportunities slowly over time, and that the financial crisis exposed risk that were previously unknown to CDS sellers. ◆

Monetary Shocks and Bank Balance Sheets

Sebastian Di Tella and **Pablo Kurlat**

A fundamental problem that banks face is that their loans tend to be long term assets, but their deposits tend to be short term liabilities. This means that if nominal interest rates increase, banks are exposed to the risk of capital losses. Banks have tried to hedge against this risk using interest rate derivatives, but small banks tend not to do this, and large banks, if anything, increase exposure using derivatives. Di Tella and Kurlat construct a model to try and explain why banks do this.

Their model contains two types of agents, households and bankers, who have identical preferences over a CES aggregate of consumption and money. Money is a CES aggregate itself of real currency holdings and real deposit holdings, which are close substitutes. Bankers are able to issue deposits to households but are constrained in their level of issuance by a leverage limit, which is a function of their net worth. The deposits pay bankers an endogenous nominal rate known as the deposit spread.

Monetary policy in the model is not optimal, it is random and determined by Brownian motion. This random process contains all of the uncertainty in the model. Bankers can trade exposure to the Brownian motion. The price of exposure is determined endogenously, and the market for exposure is complete in the sense that banks can make any trade they wish to in this market.

In equilibrium, the deposit spread rises with inflation because the demand for deposits rises as households substitute away from cash holdings. Pablo Kurlat showed empirical evidence to support this equilibrium finding. Banks earn a higher return when inflation is high because of this relationship between inflation and deposit spreads. Since banks are risk averse, they are willing to take a loss in high inflation states when they are making larger spreads than normal. They do this to transfer risk from high return states to low return states when inflation is low. This is the key model mechanism that this paper tries to demonstrate.

The authors then calibrate their model to see how bank's exposure, that is their holdings of wealth, change in response to interest rate shocks. Their calibrated model has the right qualitative findings, but quantitatively the effects are very small. When interest rates rise one percent, wealth falls by about one percent; empirical evidence suggests the exposure is much larger than this. They do a back of the envelope calculation to show that the correct empirical target is a 16.6 percent fall in wealth following a one percent rise in the interest rate.

Pablo Kurlat made several guesses as to why their model misses the mark quantitatively. One possibility is that the mechanism they examine is not the right one. Banks might be choosing their levels of deposits differently from what they do in the model, and this would change the quantitative results they generate. Another possible problem is that in the model, when banks get richer, they supply more deposits and drive down spreads. This reduces the wealth effect of interest rate changes. Empirical evidence suggests this does not happen in actuality, and so the model can be adjusted to remove this. In the current version of the model, the leverage limit is used to prevent competing away the deposit spread. Alternatively, they could model banks as imperfect competitors which would mean bank wealth has no effect on spreads. A third possible problem is that in the model, spreads mean revert faster than interest rates following a shock, which mutes the wealth effects of these shocks.

Ed Nosal was the discussant for this paper. His discussion focused on how Di Tella and Kurlat model the demand for money. Their paper takes a shortcut by sticking money and demand deposits into the utility function. This is standard in the literature, but Nosal worries that this is not justified in this framework. The model has full commitment and perfect monitoring, which means money is not essential. If full commitment or perfect monitoring were relaxed, then money would be essential, but Nosal suggests some of the results could change. ◆

Financial Frictions in Production Networks

Saki Bigio and Jennifer La'O

Bigio and La'O analyze how the financial frictions on the production of firms manifest themselves in macroeconomy. They built a theoretical model which has financial constraints on working capital. Besides the size of the industry, they show that the organization of the industry and location of firms matter for the effect of financial shocks; whether the firms are not linked, or they are ordered in supply-chain, imply different amplification mechanisms of credit constraints.

The model is a generalization of Acemoglu et al., (2012) and Jones (2011). There is a representative household and N productive sectors. The production function is decreasing returns to scale in TFP and intermediate input composite where inputs are combined with a Cobb-Douglas technology.

They assume constant returns to scale in construction of intermediate input. Firms are maximizing profit, subject to a financial constraint, which says that not more than a proportion of their sales can be used for expenses of inputs. The constraint can come from a working capital need. The only difference of the model from the standard input-output linkages are the financial frictions. The model exhibits no dynamics, equilibrium is steady state.

The authors decompose the aggregate effects into efficiency wedge and labor wedge. How the network is structured determines how the shocks are propagated and how these wedges are affected. So, in the model there are two forces that determine the diffusion of shocks: input misallocation and the labor wedge. Given the amount of labor, financial frictions distort the optimal sectoral allocation of labor. The difference between the marginal rate of substitution and the marginal product of labor. When sectors are more constrained, the firms have to hire less workers and wage absorbs part of the financial shock, real wages fall which creates the labor wedge.

The paper considers three economies to analyze the impact of network structure: chain economy, horizontal economy, and hybrid economy. Chain (vertical) economy is such that labor is only supplied to the first firm, then that firm supplies input to the second firm, and the second to the third firm. Final output that the households use is the production of the third firm. Horizontal economy is the typical one seen in macro models, where firms produce in isolation, and each uses labor as input to produce a final output. Hybrid economy is the most similar to the architecture of the US economy. It is similar to the chain economy in terms of input-output linkages, but it differs in the sense that each firm uses labor separately.

These economies are set up so that they all have the same output in the absence of financial frictions, but shocks matter in different ways depending on how the production is organized. In the chain economy, there are no efficiency losses of a financial shock to the aggregate economy because labor is allocated in a particular way. However, there arises labor wedge which is compounded with the frictions of each sector. In a horizontal economy, there are efficiency effects but the effects are symmetric. If the shocks to each sector are symmetric, there is no efficiency wedge. There appears a labor wedge which is only additive in this case. For the hybrid economy, the effects are asymmetric. Sectoral shocks to the most downstream firms have the greatest aggregate effects. Moreover, an aggregate shock to the economy has the greatest effect on the most upstream, primary sectors.

In the quantitative exercise of the model, the authors show that financial frictions have multiplier effects, where the liquidity multiplier is defined as the drop in aggregate output by a 1% fall in the financial constraint. For an economy where the input-output linkages are calibrated to input-output of the U.S., they get a multiple of 2.5, where 0.9 of this multiple is coming from the efficiency wedge that is purely a misallocation of labor, and the rest is from labor supply decisions (i.e., labor wedge). However, when only a representative firm is assumed in the model, the output falls by 0.7% which indicates the importance of input-output linkages.

As for the most vulnerable sectors, when the credit constraints are tightened by 1% uniformly in all sectors, the greatest decline happens in the upstream manufacturing sectors (e.g., chemicals and metals). Regarding the most influential sectors, when the constraints are tightened individually, in terms of location, the most downstream sectors have the greatest effect on aggregate output (e.g., construction sector). In terms of size, government and hospitals are important. In order to explain the drop in output, hours and labor wedge in the US economy during the Great Recession, the liquidity has to drop 1.3% of sales on average at trough of the recession. This result shows how a seemingly small friction can amplify in the aggregate economy.

The discussant argued that having a fixed factor is crucial for the results. Any sector that has financially constrained must necessarily have decreasing returns to scale. Part of the paper depends on the example of constant returns to scale technology, and that part is not quite right, because either the only optimal solution is producing no output or the constraint is violated with the given assumption. Hence, decreasing returns to scale in sectoral level, not just in individual firm, is essential to generate the results of the paper; there must be fixed factors across sector. The fixed factor at the level of the sector is important: whether it is land, capital, or span of control of managers, etc., must be defended in the calibration. Bigio replied that most of the paper is built on the decreasing returns to scale technology except that example, hence the results are valid. A participant asked how he backed up which sectors are most affected or most influential. Bigio replied that he used two methods: by markups and by fire sales. The numbers can differ based on which method is used, but the rankings are similar. Another participant pointed out that tightening financial constraints is equivalent to requiring higher profit margins which is surprising. Bigio agreed, and he knows that markups are doing poorly, there could be fixed costs. For example, oil is a big loser industry during recession, however it is not by financial constraints but by prices, etc. ◆

Firm Selection and Corporate Cash Holdings

Juliane Begenau and Berardino Palazzo

Over the last 30 years, the average cash-to-assets ratio of publicly traded firms in the United States has been on the rise. In fact, it rose from about 0.15 in 1960 to 0.25 in 2010. The literature up to this point has focused on explaining this trend by analyzing within-firm effects. This could take the form of increased agency conflicts and precautionary saving motives, more multinationals than expatriate taxes, or changes in the

cost of holding cash. Begenau and Palazzo suggest that this trend may be better explained by high R&D firms replacing low R&D firms, and these high R&D firms entering with more cash. The authors point to another trend to motivate this idea: both the fraction of active R&D-intensive firms, and the fraction of R&D-intensive firms entering the market have risen dramatically in the last 50 years. Furthermore, it appears that high-R&D and low-R&D firm types are persistent throughout the life of the firm. This paper determines to what degree an industry dynamics model can explain the recent evolution of the cash-to-asset ratio's cross-sectional mean for U.S. public companies.

Using data from Compustat, Begenau and Palazzo decompose the change in the average cash-to-asset ratio into a within-firm effect and a selection effect. They find that the within-firm effect is actually negative, and the selection effect's contribution is positive and almost double the magnitude. R&D-intensive firms account for 81% of this selection effect. Selection, therefore, plays a large role in explaining the trend in the data.

To analyze this phenomenon, the authors construct a firm dynamics model with decreasing returns-to-scale production and idiosyncratic productivity shocks. There are two types of firms. Low-R&D firms have access to tangible capital that can be used as collateral. High-R&D firms, in contrast, rely on intangible capital that cannot be used as collateral. The financial market is modelled with frictions such as the tax advantage of debt financing. Finally, firms decide to enter endogenously, but exit is exogenous. Begenau lays out the model in detail and explains the problem facing the low-R&D incumbents, high-R&D incumbents, and new entrants. There is a constant mass of firms that can decide to go public each period. These firms receive a signal, q, and face IPO entry cost, c, which depends on their type. One mechanism suggested for the observed trend is that high-R&D firms face lower IPO costs than low-R&D firms. An industry equilibrium is reached when the firm distribution is stationary and consistent with the Markov distribution of the idiosyncratic shocks and the decisions of incumbents and entrants.

Begenau and Palazzo calibrate key model parameters to match 1959-1979 moments. Namely, they choose parameter values in an attempt to match the cash holdings of high-R&D incumbents, the cash holdings of high-R&D entrants, the equity-to-asset ratio of high-R&D firms, and the net debt-to-asset ratio of low-R&D firms.

Two experiments were presented next. In this section, Begenau also uses the terms new-economy firms and old-economy firms to mean high-R&D firms and low-R&D firms respectively. The first experiment asks what happens to average cash holdings when the share of high-R&D firms is exogenously increased. Changing the composition of the entrant pool increases the average cash holding and the fraction of new firms, but does not match the change in cash holdings at entry. The second experiment determines the effect of a reduction in the cost of entry (IPO cost) for high-R&D firms. When these two changes are made simultaneously, the model is able to produce an evolution of the average cash-to-asset ratio that resembles the data.

The authors are working on expanding the model to include adjustment costs for capital. They also would like to explore tax avoidance as a potential explanation for the observed trend and determine the contribution of venture capital in lowering IPO costs for R&D-intensive firms.

Begenau's presentation was followed up by a discussion by Steffano Sacchetto. He noted that this paper addresses an important puzzle in corporate finance. This analysis is somewhat limited, however, due to using a partial equilibrium model. One implication of lowering the cost of entry for high-R&D firms in the model is that productivity at entry for those firms decreases over time. Sacchetto used firm-level TFP data from another paper and found that the opposite is observed. He also asked where the evidence is of lower entry costs for high-R&D firms. ◆

The Market Price of Capital Misallocation

Cedric Ehouarne, **Lars-Alexander Kuehn** and David Schreindorfer

Recent empirical research in macroeconomics and finance documents a large degree of business cycle variability in the cross-sectional distribution of firms' capital, and in particular in the second and higher moments of these distributions. Yet, little attention has been paid to the implications of this variability for aggregate quantities, such as aggregate consumption and equity premia.

In their paper, Ehouarne, Kuhen and Schreindorfer (EKS) study how the dynamics of the cross-sectional distribution of firms' capital impact aggregate fluctuations and equity returns through the channel of capital misallocation. Their stochastic general equilibrium model of production features a representative household with recursive preferences, and a continuum of firms facing both aggregate and idiosyncratic productivity shocks.

In contrast with the previous literature, the idiosyncratic shocks are permanent and exhibit rare but large negative jumps, in turn generating time-varying dispersion in the second and higher moments of firms' capital distribution and stock returns. These assumptions for the idiosyncratic productivity process, coupled with additional assumptions on irreversible investment and firm exit, generate an economy populated by few large firms whose negative idiosyncratic shocks matter disproportionally for aggregate consumption, and many smaller firms that are prevented from expanding, especially in bad times. Additionally, the permanent nature of idiosyncratic shocks generates long-

lasting effects on aggregate consumption on the household side, and translates into a high equity premium under recursive preferences.

The preliminary results of the paper show that the model is capable of generating first and higher moments of the sales growth distribution that closely match the data, and business cycle quantities (e.g., standard deviation of output, consumption and investment growth, capital misallocation) that are closer to the data than those coming from a frictionless real business cycle (RBC) model. Finally, the model generates a sizable equity premium.

The discussant, Rüdiger Bachmann, emphasized that the ability of the EKS model of generating cyclical movements in the consumption distribution by modeling the production side of the economy makes the model potentially able to ask a broad set of questions. To this extent, he invited the authors to clarify the quantitative impact of different modeling assumptions (in particular investment irreversibility and recursive preferences) in obtaining the current results. Finally, he raised some technical concerns about the model parametrization and estimation, as well as about the ability of the EKS model to match some business cycle moments, relative to the RBC model.

The audience stressed the difference between EKS misallocation, intended as departure from the RBC model, and misallocation intended as departure from the solution to a planning problem with similar technological constraints. Moreover, the audience highlighted the potential of the model in quantitatively addressing questions about capital reallocation within, and across different industries. ◆

Managing Risk Taking with Interest Rate Policy and Financial Regulation

Simona E. Cociuba, Malik Shukayev and Alexander Ueberfeldt

How should monetary policy and financial regulation be modified to induce prudent portfolio choices by banks? Collateralized borrowing via repurchase agreements have grown tremendously since the 1980s, and played an important role in the recent financial crisis. The collateral used in repo markets are usually government bonds, and the cost of borrowing is tightly linked to the fed funds rate. Cociuba, Shukayev, and Ueberfeldt answer this questions using a general equilibrium model with limited liability and deposit insurance, making risky investments attractive for financial intermediaries. They use their model to find the interest rate policy that succeeds in preventing financial intermediaries from taking on too much risk. They can then determine the economic cost from failing to implement the optimal interest rate policy.

The model features a representative household, firms in two sectors (financial and non-financial), a government, and financial intermediaries. Financial sector firms have limited liability and are financed via equity and insured deposits. The firms invest in risk-free government bonds or risky projects where the probability of success depends on the aggregate state of the economy. Non-financial firms are financed entirely through equity, and invest all equity into capital used for production. The government issues bonds, sets taxes, provides deposit insurance to banks, and sets financial regulation. Financial regulation takes the form of lower limits on both the ratio between equity and risky investments, as well as the ratio between leverage and risky investments. Financial intermediaries solve a portfolio choice problem by choosing how much to invest in risky projects as opposed to safe government bonds.

When there is no bankruptcy allowed, whether or not the financial intermediaries take on too much risk depends on whether the discount rate is higher, lower, or equal to the interest rate. When bankruptcy is allowed, interest rate policy must be accompanied by regulation on capital and leverage. Numerical simulations show that following the socially optimal policy can provide important improvements in reducing the risk assumed by financial intermediaries.

The discussion centered on the differences between different kinds of regulation, and how some regulations may be better than others in reducing risk. One listener pointed out that in the model, capital regulation does not affect bond holdings significantly, whereas leverage regulation does. Consequently, the limit on the ratio between leverage and risky investments is a more useful tool for policymakers. Another listener responded by pointing out that only capital regulation is responsible for the observed spread in interest rates between bonds and deposits. There was agreement that coordination between interest rate policy and other regulations are important, and not all regulations will achieve the same outcome.

Another point of discussion related to how the model was constructed. One listener cited a "legend" in welfare economics asserting that inefficiencies can be overcome if there are as many policy instruments as there are market frictions. In this model there are two policy instruments, and two frictions, so it makes sense that the competitive equilibrium can be efficient. The additional features of the model make the model more realistic and empirically relevant. ◆

Financing Intangible Capital

Qi Sun and **Mindy X. Zhang**

Intangible capital, which is characterized by R&D and innovation activities of firms, increasingly plays the part of the production function. How the intangible investment is financed remains an open question in the corporate finance literature. Intangible capital is believed to have low collateral value, hence the traditional financing instruments cannot be used to finance intangible investment. The paper proposes that the intangible investment is financed by borrowing from employees, becoming collateral in wage contracts.

The authors first show the evidence that the correlation between intangible capital investment and the traditional financing channels, namely debt issuance and regular equity issuance, is very low. However, intangible capital investment is highly correlated with the equity issuance to employees. In the time-series analysis, the correlation coefficient between intangible investment, by proxy of R&D expenses, and employee financing, Stock Based Compensation (SBC) from Compustat data, is 0.59. However, the correlation coefficient of intangible investment with equity issuance is 0.27, and with debt issuance is only 0.03 which is much lower than the correlation of the physical investment with these traditional financing tools. In the reduced-form panel regressions, the authors show that the intangible investment is positively correlated with SBC, both in traditional industries and in high-tech industries, however the coefficient of SBC in the high-tech industry sample more than doubles that of SBC in the traditional industry sample. In terms of physical capital, the two industries do not differ.

Based on empirical evidence, the authors build a theoretical model with dynamic wage contracting that explains the patterns observed in the data. In the model the firm determines the optimal wage contracts, intangible investment, and financing through equity or debt issuance in an environment with both financial and labor market frictions. Firms have full commitment to debt contracts represented by an enforcement contract in the firm problem. However, risk averse employees have limited commitment to the wage contract; they can walk away whenever an outside option is better than the contract. An employee can leave the firm with a constant fraction ("collateral rate") of intangible capital which is called a partial portability assumption. Due to this portability, the firm offers long term contracts that will guarantee the participation of the employee. Hence, deferring wage compensations in the long term contracts, such that the participation constraint is still satisfied, introduces a new channel for financing investment for the firm. The firm can offer lower wages today in exchange for higher wages in the future, so that the lifetime utility of the employee does not change. The available funds today are used to finance the intangible capital investment.

From the model, the authors define two financial effects of wage contracts, which they call 'precautionary effect' and 'overhang effect'. The precautionary effect is such that firms have a financial buffer and operating buffer to avoid financial distress. When the debt enforcement constraint on the firm, and the participation constraint of employee in the firm optimization problem is not binding, the slackness of the constraints are defined as a financial buffer for the enforcement constraint and a labor-induced operating buffer for the participation constraint. When there is a positive productivity shock, intangible investment increases, an employee's outside option increases since s/he can walk away with a fraction of investment, the shadow price of the operating buffer is higher which leads to a higher level of financial buffer and a lower level of operating buffer. In the case of a negative shock, the opposite happens. Investment decreases, firms save more of an operating buffer, and less of a financial buffer. Debt capacity is endogenously determined by the interaction between the enforcement constraint and the participation constraint which is called the 'intangible capital overhang effect'. The accumulation of intangible capital increases employees' outside options which increases deferred employee claims. This reduces net worth of the shareholder, which results in lower expected borrowing capacity from debt holders.

Furthermore, the authors estimate the key parameters of the structural model using Simulated Method of Moments. The model matches with the empirical moments, especially with average leverage and in line with the evidence seen in the time-series analysis and reduced form regression. The correlation of R&D investment with employee equity issuance is positive, and with debt issuance is negative.

One of the participants asked whether the separation of the firm and the worker is dependent on the persistence of the productivity shock. Zhang answered that there is no separation in the model. As long as the match between worker and firm is greater than zero, they won't separate. This depends on the dividend flows, which are not going to go to negative in the model. The discussant, Hengjie Ai, argued that firm size is important in terms of compensation response to shocks; the small firm is expected to have more negative response (it can cut more wages as the outside options of the worker are not binding), but the large firm is closer to a binding constraint, so it has to increase wages with a positive shock which creates more positive response. Zhang replied that the model does not incorporate size effects as there is no physical capital, and measuring accumulation of intangible capital, h, and its depreciation rate is the problem thus far. The discussant also argued that the adjustment cost introduces risk aversion to the firm side. On the quantitative side, the implied risk aversion will be an important parameter. Moreover, the discussant suggested to report some first moments. Zhang replied that they introduced stickiness into dividends and risk aversion in order to match the smooth dividend flows in data which brings risk sharing. As for the first moments in calibration, the paper doesn't target first moments since the model does not have physical capital, but the first moments in the data includes physical capital. One of the participants suggested Zhang look at the labor literature where there is a consensus on the intangible collateral rate parameter around 0.7, while this paper has a number around 0.3. However, the subjects in the labor literature may be more general workers, whereas this paper only has engineers, etc., the structural studies in labor literature might still be helpful in terms of guiding a good benchmark of the parameter. ◆

The Globalization Risk Premium

Jean-Noel Barrot, **Erik Loualiche** and Julien Sauvagnat

Who benefits and who loses from international trade? The positive neo-classical consensus that trade should lead to an efficient reallocation of inputs across countries has recently been challenged by research highlighting the negative impact of trade on incumbent firms and local labor markets. In particular, recent studies show that the opening of trade barriers to countries with low production cost has adversely affected domestic employment in the United States.

In their paper, Barrot, Loualiche and Sauvagnat (BLS) explore the implications of international trade through the lens of the risk-return tradeoff, by asking whether the expected returns on industries characterized by high exposure to trade are higher than those of industries characterized by low exposure to trade. The authors use a persistent structural measure of firm transportation costs, the markup of Cost-Insurance-Freight value over Free-on-Board value (CIF), as an industry proxy for exposure to trade. Using exogenous variations in tariff changes the authors show that output, employment, and returns of firms in industries with high exposure to trade are more sensitive to changes in tariffs than firms in industries with low exposure. In particular, employment, shipment, value added growth, and stock returns in low CIF sectors significantly drop following a drop in tariffs.

To explore these empirical findings the authors build on the standard Melitz-Chaney model of trade. The model features a finite number of countries, each one populated by a representative household, and by a finite number of industries, each populated by a continuum of firms. Firms in each sector operate within monopolistic competition, and their profits depend on the elasticity of substitution across goods in an industry, and on the relative economic distance of a country with respect to the others in that sector. On the household side, households supply labor inelastically to the domestic firms, consume a bundle of goods from different industries (whether domestic or imported), and can save by holding domestic stocks.

The model generates several predictions for the impact of trade competition. On the firm side, domestic firms suffer from import competition both at the extensive and intensive margin. The higher the firm's exposure to international trade, the higher its displacement risk. On the household side, households benefit from high competition (price effect), but because of market segmentation suffer from a reduction in the value of domestic stocks due to firm displacement risk (wealth effect). While the model provides guidance in separating price and wealth effects, evaluating which one of the two dominates is ultimately an empirical question.

The authors test which effect dominates the household's overall utility by analyzing the sign of the premium associated with the risk of import competition. The authors find that portfolios of stocks with low CIF have higher alphas than portfolios of stocks with high CIF, and prove this result to be consistent across various robustness tests. Stocks more exposed to import competition earn higher returns, suggesting that firms' displacement risk and investors' marginal utility co-vary positively.

The discussant, Nick Roussanov, pointed out that measuring the impact of trade exposure on firm output using exogenous changes in tariffs could be misleading. Changes in tariffs are not always exogenous, but rather the outcome of negotiation – especially in industries with high transportation costs. Roussanov also highlighted that companies exposed to international trade are largely exposed to exchange rate risk, and invited the authors to disentangle this source of risk from the proposed productivity risk. Finally, he stressed the importance of the assumption of imperfect international risk sharing (due to home bias for domestic stocks) for the paper results. Loualiche acknowledged Roussanov's comments, and in particular pointed out that while the paper's goal is not to estimate the causal effect of tariff changes on output, the paper's results in this sense hold across different empirical specifications and robustness tests. ◆

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