FROM THE LAB

UC Santa Barbara | Laboratory for Aggregate Economics and Finance

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The 3rd Workshop of the Australasian Macroeconomics Society
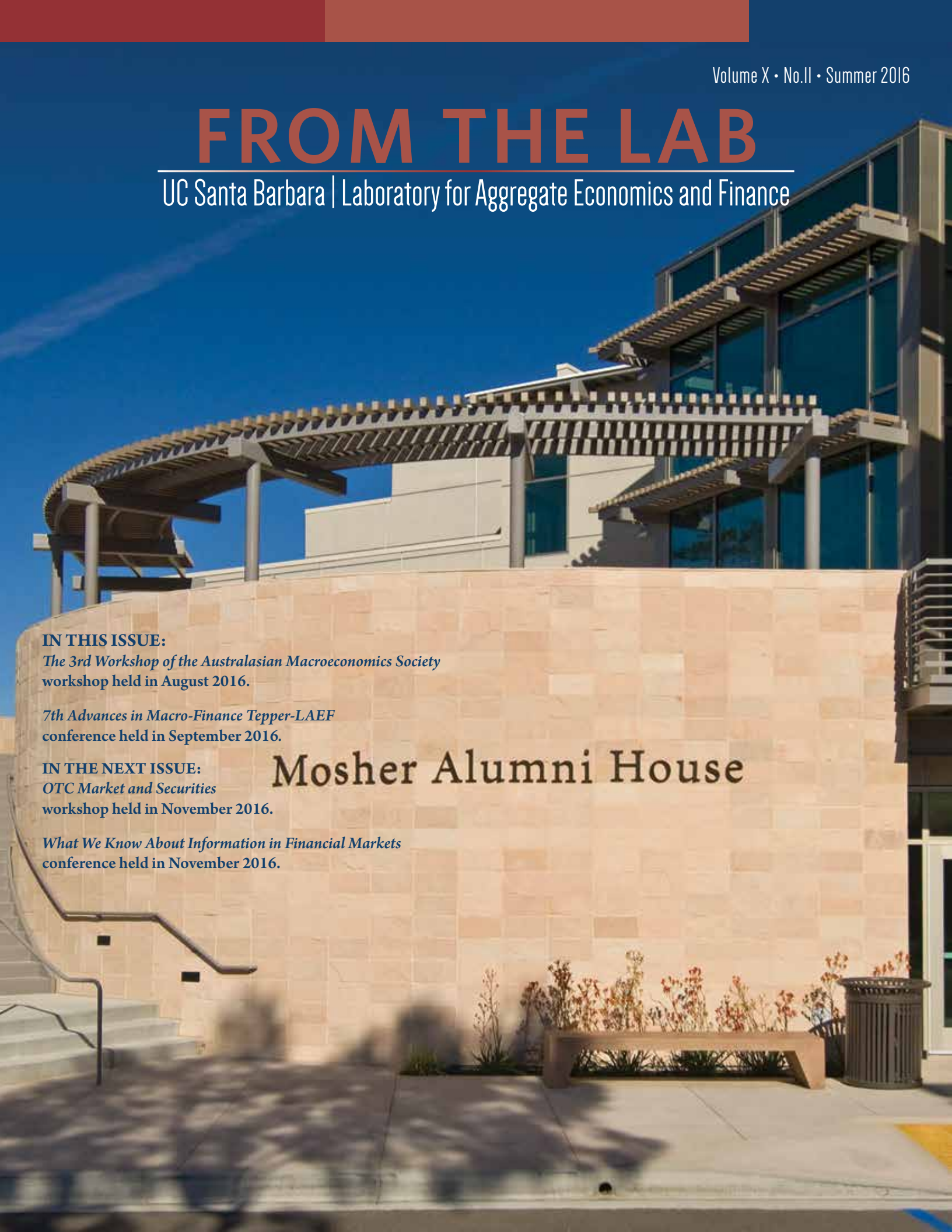**workshop held in August 2016.**

7th Advances in Macro-Finance Tepper-LAEF
conference held in September 2016.

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Mosher Alumni House

UC Santa Barbara
Laboratory for Aggregate
Economics & Finance

Director's Message
Finn Kydland

This issue contains summaries of the proceedings of two conferences. As readers of FROM THE LAB will have gathered, LAEF is open to co-operation with other universities and institutions, even far-away ones, such as, in this case, Australia. Talking about far-away places, this message contains my annual list of international activities during the past academic year. One such trip was to a location that many consider too far off, namely North Korea! At the end of this message, I'll devote a little extra space to that trip, and also to the Copenhagen Consensus Center meeting in Bangladesh on the way home.

The most long-lasting example of co-operation is that with the Tepper School of Business, Carnegie Mellon University, in organizing, now, seven annual conferences on Advances in Macro-Finance. This year, Laurence Ales and Lars Kuehn, both associate professors at the Tepper School, organized the conference in Pittsburgh. As in previous editions of the conference, papers both in macroeconomics and finance were paired with discussants in the opposite field. This issue of FROM THE LAB summarizes the eight presentations, along with the discussion taking place during the presentation of each paper.

Here is a quick preview of what was presented during the conference. It was subdivided into four sessions. The first session, with papers presented by Toni Whited and Christian Opp, focused on the measurement and a potential mechanism for the misallocation of financial assets across firms. The second session focused on the theory and measurement behind aggregate quantities. A paper presented by Barney Hartman-Glaser discussed how firm-specific shocks affect the aggregate capital share. In her presentation, Ellen McGrattan focused on the role of intangible capital in the measurement of aggregate productivity. The third session was devoted to labor markets. Yongseok Shin presented a paper looking at the implications of technical change on workers and Shu Lin Wee looked at the role of rational inattention in explaining a reduction in matching efficiency during downturns. In the final session, two papers presented by Tim Landvoigt and Satyajit Chatterjee focused on models with financial frictions. The former looked at the role of macro-prudential policies during financial recessions; the latter developed a theory of how credit scores affect unsecured consumer credit market behavior.

The 3rd Annual Workshop of the Australasian Macroeconomics Society (WAMS) was held in beautiful Brisbane, Australia, August 17-19. The conference is jointly organized with the Laboratory for Aggregate Economics and Finance. WAMS sponsors include Griffith University, Queensland University of Technology, University of Queensland, Australian National University, the Economic Society of Australia and the Reserve Bank of Australia. The keynote speakers were Fatih Guvenen, University of Minnesota and Ellen McGrattan of University of Minnesota. Fatih talked about his recent work on understanding where inequality comes from and Ellen spoke about measuring productivity.

The last day of the conference was the "LAEF" day. The program consisted of two main topics. The morning session consisted of three papers relating to monetary and fiscal policy. The afternoon session consisted of three papers about China. The six papers from that conference are summarized below. Next year we will

again collaborate with WAMS and the conference will be held in Canberra, August 17-19. More information can be obtained at http://wams2017.ausmacro.com/

KEYNOTE SPEECHES AND PUBLIC LECTURES

Sep. 10: Keynote, 10th Annual World Customs Organization Picard Conference, Baku, Azerbaijan

Nov. 13: Keynote, 2nd Annual Global Congress of Knowledge Economy, Qingdao, China

Dec. 12: Keynote, 2nd Workshop of the Australasian Macroeconomic Society, Sydney, Australia

Jan. 28: Public Lecture, Economics & Finance Society, University College London

April 4: Public Lecture, Dean's Lecture Series, Carnegie Mellon University Qatar, Doha

April 8: Keynote, Forum on Water and Sustainability, Madrid, Spain

April 20: Keynote, 23rd Global Finance Conference, Fresno, California

May 3: Public Lecture, Kim Il-Sung University, Pyongyang, North Korea

May 4: Public Lecture, Pyongyang University of Science and Technology, Pyongyang, North Korea

May 5: Public Lecture, Kim Chaek University of Technology, Pyongyang, North Korea

PANELS

Feb.-March: Oslo Business for Peace Prize, member of selection committee

May 8-12: Member of Eminent Panel, Dhaka, Bangladesh, organized by Copenhagen Consensus Center, to rank, based on benefit-cost analyses, approximately 70 different policy options and interventions for Bangladesh

June 6: Premios Jaime I (prestigious Spanish prize), member of selection committee for Economics; selection meeting took place in Valencia

EDUCATIONAL ACTIVITIES OF NOTE

June 30-July 2 (2015): XX Workshop on Dynamic Macroeconomics, Vigo, Spain; opportunity for PhD students and beginning assistant professors from all over Europe to present their research in front of five seasoned professors

June 21-23 (2016): XXI Workshop on Dynamic Macroeconomics, Vigo, Spain; opportunity for PhD students and beginning assistant professors from all over Europe (in one case, from the U.S.) to present their research in front of five seasoned professors

CORRECTION, REPORT FOR 2014-15 IN "FROM THE LAB," SUMMER 2015:

I forgot to include the following item:

May 5 (2015): Public Lecture, University of Matanzas, Cuba, at event organized by Royal Academy of Economic and Financial Sciences, Barcelona

NORTH KOREA

This was a scientific event, entitled "Bridges – Dialogues Towards a Culture of Peace" organized by International Peace Foundation (IPF), which has an office in Bangkok. My wife, Tonya, and I had participated before in one of their Bridges events (that time in Thailand and the Philippines), to which Uwe Morawetz, founding Chairman and head of their office in Bangkok, had joined us. So when he approached me about North Korea almost a year before the event was to take place, I immediately agreed. The visit was envisioned as a vehicle for enabling dialogue between six Nobel Laureates from different fields, on the one hand, and faculty and students at three universities in Pyongyang, on the other. In the end, however, three of the laureates cancelled, including the only two Americans, so that Aaron Ciechanover, Chemistry Laureate 2004, Sir Richard Roberts, Medicine Laureate 1993, and I were the only remaining ones. The cancellations meant, for example, that physics was not represented. Also, it meant that Tonya was the only American in the delegation.

Included, first of all, was Prince Alfred von Liechtenstein, Chairman of the IPF Advisory Board in Vienna. In addition to staff from IPF in Bangkok, TV and radio crew from BBC as well as The Nation – a Thai broadcasting group – joined us.

As the stay lasted exactly one week (Friday to Friday), it meant that we got to experience local life and do some sightseeing in Pyongyang. As examples, we visited the impressive Science and Technology Center, a children's hospital, Children's Palace for after-school activities (at which we were entertained by kids' spectacular performances), an amusement park, and got a view of Pyongyang from atop the 150 meter tall granite Juche Tower.

The main events took place at the three universities Monday through Thursday. At each, after our three speeches, we interacted with faculty and students in our respective fields. (Often, the faculty needed translation. Students, on the other hand, typically speak English fluently.) Aaron and Sir Richard were quite impressed with some of the research projects presented, I less so. As Aaron put it, faculty and, especially, students were clearly hungry for knowledge.

Early in our stay, we were informed that health care, education, and living quarters all are provided to everyone at no charge. Moreover, we were told, there are no taxes. The combination of these claims led Prince Alfred, who has a master's degree in economics, and me to take every opportunity we had to grill faculty and officials about how this could be consistent with the government budget constraint. We got confirmed that there is no seignorage to speak of, government borrowing and lending are not a factor, so where does the needed revenue come from? In the end, we pieced together the following as being the main factors. At a typical factory, the workers are compensated well below their marginal products. Excess revenue over cost is remitted to the government. So it's as if there were a labor income tax and, essentially, 100% capital income tax, boiling down to an issue of semantics!

This trip generated considerable media attention. I'll end with two statements made by Prince Alfred in media interviews:

"My prediction is that if there is no major crisis, Pyongyang will become another Singapore within 15 to 20 years, with science and technology institutions and hi-tech companies and a highly educated workforce and government pushing hard in this field. It's amazing that the government is encouraging the new generation to learn and speak English. Studying English was made obligatory starting at primary schools two years ago. That means that in 10 to 15 years, English will become their second language. This is what they want."

and:

"You may have disagreement and conflicts, but mathematics and science are a universal language. One and one equals two wherever you are. The spearhead of international dialogue has always been the scientists, because they speak the same language. Therefore, we have a good start here. And it has nothing to do with politics. We try to find common ground to bring people together."

I suppose we can all agree with this last statement. The first, however, seems a tad optimistic. We'll have to wait and see! One may also wonder about the practicality in the near term of the English-language goal. Are there enough teachers with sufficient command of English to make it feasible?

COPENHAGEN CONSENSUS CENTER PANEL – RANKING SOLUTIONS FOR BANGLADESH

In last year's report, I talked extensively about CCC's panel to rank the UN's 169 goals to 2030. That was the fifth time I had participated in a CCC panel. In the past, I had participated (twice, at four-year interval) to evaluate solutions to world problems, to Latin American problems, and to climate change problems. (A faithful member of several panels, Thomas Schelling, who also participated in the panel on UN goals, died in December at the age of 95.) Now, for the first time, CCC, headed by their director, Bjørn Lomborg, was to take on the problems of one individual nation – Bangladesh. (They are preparing to do Haiti next.) The panel meeting took place in Dhaka. In all, 76 solutions were considered, covering themes from poverty and health to education, infrastructure, and gender inequality.

The CCC has found a formula that works, so that the process is always the same. In advance of the panel meeting, world experts in the various sub-areas are commissioned to write research papers proposing and evaluating, mainly according to benefit/cost criteria, what they regard as their most promising solutions in their particular areas. These papers are then distributed to the panel members in advance, enabling a preliminary ranking. In each area, a second expert is lined up to comment critically on the first expert's solutions and justifications. Then the panel convenes to discuss the solutions, usually with one author per research paper present to provide a brief summary and answer the panel's probing questions. On the first day of the panel meeting, each panel member has been furnished with a magnetic board on which, as area after area is presented and discussed (sometimes hotly among the panel members), thin magnetic strips containing solution titles are placed on the board in tentative order of ranking. After the last area has been presented, the panel is then given time to place the entire ranking in order, after which the ranking is aggregated to produce the final published ranking.

The panel's task is more challenging than simply comparing "headline" figures for each solution's benefit/ cost ratio. Indeed, various members may place additional emphasis on various related issues, such as

the perceived extent of uncertainty associated with that benefit/cost ratio, the timing of the potential execution of the proposed solution, and perhaps other factors. In the case of the Bangladesh panel, three of the members were natives of Bangladesh and may have had their own biases. As a consequence, my impression was that their rankings deviated from the ranking of benefit/cost ratios to a greater extent than I've been used to in previous panels.

Here are CCC's brief descriptions of the top three priorities:

TUBERCULOSIS

TB kills 80,000 Bangladeshis each year. Halting this death toll would stop nearly one in every eleven Bangladeshi deaths. Research by Dr. Anna Vassall, senior lecturer in health economics at the London School of Hygiene and Tropical Medicine, outlines a cost-effective TB treatment strategy using community health clinics that costs just Tk 7,850 per patient. Treating one person can save multiple lives. In total, each taka will achieve 21 takas of good.

DIGITAL BANGLADESH

Bangladesh spends more than Tk 720 billion (about $9 billion) on public procurement annually. Making this process more efficient would avoid delays and cost overruns and increase efficiency. Research by Dr. Wahid Abdallah, a research fellow at the BRAC Institute of Governance and Development and Assistant Professor, BRAC University, shows that each taka spent on digital procurement will achieve 663 takas of good. In addition, research by Sultan Hafeez Rahman, Executive Director of the BRAC Institute of Governance and Development, finds that creating electronic land records would provide an incredible 619 takas of benefits per taka spent.

INFANT NUTRITION

Bangladesh has had great success fighting hunger, but there is more work to do. Stunting affects around 6 million Bangladeshi children under age five, decreasing cognitive development, and leading to worse health outcomes, school performance, and productivity. New research by Jonathan Rose, a research advisor with the South Asian Institute of Advanced Legal and Human Rights Studies, examines programs to fight malnutrition by delivering nutrients and micronutrients to young children and pregnant mothers. Rose's research estimates that if these supplements were delivered to everyone, stunting would fall from 36 percent to an estimated 29 percent—averting stunting in roughly 450,000 children.

Other very high-ranked policy ideas for Bangladesh include: greater investment in transportation infrastructure to mitigate the need for private automobiles, motorcycles, auto-rickshaws, and cycle-rickshaws; efforts to increase secondary school education for girls; and providing iron and folic acid supplements during pregnancy, to improve health outcomes for mothers and their young children.

The 3rd Workshop of the Australasian Macroeconomics Society

AUGUST 17- 19, 2016

CONFERENCE PARTICIPANTS

Zainab Asif - Queensland University of Technology

Andres Bellofatto - University of Queensland

Francesco Carli- Deakin University

Fabrizio Carmignani -Griffith University

Efrem Castelnuovo - University of Melbourne

Gonzalo Castex - Central Bank of Chile

Andreas Chai- Griffith University

Albert Lee Chun - University of Queensland, Business

Guilherme de Almeida - European University Institute

Begona Dominguez - University of Queensland

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Hans Fehr - University of Wuerzburg

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Benjamin Griffy - University of California, Santa Barbara

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Fatih Guvenen -University of Minnesota

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Chao He - Shanghai University of Finance and Economics

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Ayse Imrohoroglu - University of Southern California

Benoit Julien - University of New South Wales

Emile Kaldany - Bates College

Timothy Kam - Australian National University

Marek Kapicka - University of California, Santa Barbara

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Ellen McGrattan -University of Minnesota

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Nalini Prasad - University of New South Wales

Andrew Rendall – University of Zurich

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David Wiczer – Reserve Bank of St Louis

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Yao Yao – Victoria University of Wellington

Pension Reform with Entrepreneurial Choice
Hans Fehr and Florian Hofbauer

The authors analyze the effect of three different retirement systems in an overlapping generations model. Using this model, they assess the effect of these systems on occupational choice, focusing on entry and exit into entrepreneurship. While there are many theories on the drivers of the decision to become an entrepreneur, the authors document that these rationales are often unsatisfactory, or shown to be incorrect in some datasets. One common explanation is that entrepreneurs are able to save more in order to take on more risk, but this doesn't appear to be the case in some countries. In the paper, the authors show that under some social security systems, this phenomenon shows up endogenously, as a result of fewer social safety nets. Specifically, the proposed pension systems differentially treat employees and self-employed workers. Labor supply decisions, thought of here as the decision to become an entrepreneur or not, are distorted by the imposition of new policies. They argue that this explains how entrepreneurs are observed in some counties with higher levels of savings (like Germany), while they are observed with about identical levels of savings in other countries, both relative to workers who do not engage in entrepreneurial activity. They then show how social safety nets can be used to encourage or discourage the prevalence of entrepreneurs, and compare the effects of various social security systems on innovation.

The authors approach the question by using an overlapping generations model, with a great deal of embedded heterogeneity. When born, agents start with no assets and receive a permanent skill shock. Their lifespan is stochastic until a terminal period, and depends at each age on their skill level. At each period in time, workers make a decision about whether to remain employed in the "corporate sector," or branch off and become entrepreneurs. While employed in the corporate sector, these agents accumulate social security "points," which they are awarded upon retirement. If agents choose to become entrepreneurs, they can borrow up to a fraction of their current net worth for their business to finance capital. The corporate sector is populated by a set of competitive firms employing Cobb-Douglas technology. Finally, the model also contains a government whose job is to finance government expenditures as well as the retirement system. The tax system is styled as a progressive system to mirror Germany's system in 2014, and they use consumption taxes to balance the tax during each period. Importantly, contributions to social security can only be deducted from taxes if the individual is defined to be a contributor, which may alter entrepreneurial decisions. Pensions are then paid out as a function of these earning credits, as well as the average level of income in the economy at the time.

Because of the complexity of the model, there are a large number of parameters to calibrate. Agents are started at age 20, forced to retire at age 65, and assumed dead by age 100. Further, the parameters match survival probabilities to life tables by skill classes, of which there are assumed to be three. Startup costs are calibrated to the estimated lost utility from a related paper, with mostly standard parameters for preferences and technology. The authors model the tax system after the German system in 2014, specifically allowing for a high degree of progressivity. Then they turn to the main experiment of the paper: simulating the model for three different social security regimes. First, they test a "comprehensive paygo" system, in which all entrepreneurs contribute to the pension system (meaning entrepreneurs reap the tax benefits of this savings program), and find that this increases the number of entrepreneurs by 0.8 percent. Because this decreases the need for personal savings, this also leads to a decline in assets and capital, and an overall decline in wages. The welfare results are ambiguous, depending upon the redistribution scheme. Second, they consider a "flat benefit" system in which households are given a pension regardless of income and contribution. This causes no change in the number of entrepreneurs, but a large decline in overall savings as well as in hours worked. Because this increases the contribution required, this policy is universally bad from a welfare perspective. Finally, they consider a "pension funding" system in which households are expected to save for retirement without assistance from the government. This causes an increase in the number of entrepreneurs, as well as a large increase in private savings. This again has variable effects on welfare depending upon the redistribution mechanism.

Audience members were worried about a few omissions from the model. One was concerned that changes in the demographic structure might affect the model, but the first author replied that he did not think it would change the answer to the question. Another audience member was concerned that bankruptcy would invite convexity problems into the model. The first author responded that entrepreneurs leave and then become workers, which limits the extent of the risk structure of the model. Finally, one audience member wondered if transfers to entrepreneurs would be a more effective mechanism, and the first author agreed that this was an interesting question. ◆

Optimal Central Bank Policy in a Model of Regional Shocks and Private Information

Pamela Labadie

The author assesses optimal monetary policy when regional banks face uncertainty over liquidity needs and agents can hide their own liquidity needs. While a Central Bank can limit regional risk by smoothing liquidity needs across the country, a poorly designed mechanism can cause incentive problems for agents in the economy. This restricts the operable policies of the Central Bank to require a range of ratios of short to long term assets in portfolios for regional banks participating in the interbank lending market. This has applications not only to countries like the United States, but also to currency unions, like the EU.

In the model, there is a financial intermediary and a continuum of households at each location. There are three periods, each of which serves a different purpose for agents in the model. During the first period, households are endowed a fixed quantity of consumption, and are given the option to save a divisible quantity of this good in one of the regional financial institutions. Upon receiving deposits, the regional bank chooses to allocate resources between a short-term project, whose returns are realized during the second period, and a long-term project, whose returns are realized during the third period. The long-term project cannot be interrupted, which occasionally creates a need for additional resources during the second period. Consumers can either be "early consumers" – meaning they will place a larger weight on consumption during the second period – or "patient consumers" – who are willing to wait longer for consumption. The composition of the consumers who deposit their savings at each of the regional banks is unknown when the bank makes investment decisions, which may cause banks to require additional resources if there are many early consumers and the bank has placed many resources into the long-term project. If realizations of this random variable are publicly observable, then the first-best solution is possible, and achieved by allowing banks to reallocate liquidity through an interbank lending market. However, if regional liquidity shocks are private, high risk banks act as if they are low risk banks, which allows them to receive low-interest loans while achieving high yields from their risky assets.

The rest of the paper is concerned with designing a mechanism to achieve the constrained best allocation, given the private information of the regional banks. The author imposes Cobb-Douglas production and logarithmic preferences to obtain closed-form solutions. She describes three separate economies. In the first, liquidity needs are publicly observable, and thus banks cannot "game" other banks to increase returns. In the second, liquidity needs are private and there is no central bank that can introduce a mechanism. In the third, there is a central bank that can introduce a mechanism designed to limit the ability of regional banks to take advantage of others in the interbank market. Under complete information, a contingent claims market exists for the regional banks. In an economy without a central bank that can control liquidity requirements, this contingent claims market falls apart, as these regional banks can assert that they have different liquidity needs. As the number of impatient consumers increases, the bank requires a larger and larger loan to satisfy their liquidity needs. This depresses the returns of the patient consumers, as a larger share of the return to the long-term project is paid in interest. As a result, banks find it optimal to increase investment in the long-term asset, and then indicate that they have high liquidity needs in equilibrium, in order to meet the demands of their impatient consumers. The result is a lower interest rate in equilibrium (determined by investment in the long-term project), and under provision of short-term investment. When a central bank intervenes, it can ameliorate some of these problems. While it cannot directly observe liquidity needs, the central bank can require regional banks to respect a liquidity ratio. This limits the extent to which banks can take on long-term risk, but does harm banks who truly have a large number of patient consumers. This intervention is welfare improving relative to the competitive equilibrium, but still does not achieve the first-best.

One member of the audience wasn't sure what the presence of the Central Bank changed in the equilibrium outcome. The author noted that it breaks a link between portfolio allocation and interest rates. Another audience member wondered why a mechanism like deposit insurance couldn't implement the first-best. The author noted that because of the presence of non-convexities, this would be very difficult to decentralize. ◆

Quantifying the Welfare Gains from History Dependent Income Taxation
Marek Kapicka

The author constructs a model that generates analytical answers to questions about tax systems and welfare. In particular, he shows that taxation systems that depend upon lifetime incomes are welfare-improving by allowing agents to more easily smooth consumption. In the model, the author derives a formula for the weights on historical income for the optimal tax scheme. He finds that such a tax scheme is welfare-improving, generating gains of about 1.77 percent in terms of consumption equivalent variation. He finds that most of the effect is through the insurance channel (i.e., limiting the degree to which the tax burden varies over time), rather than through a labor supply channel. In particular, the optimal scheme is less progressive than the present scheme for current income, but more progressive in its taxation of previous income.

The author employs a heterogeneous agent, perpetual-youth-style, overlapping generations framework to answer this question. Agents face uninsurable shocks to their productivity over time, which translate into uncertainty about wages in each period. They also face shocks to their disutility of labor during each period. They face a probability of dying each period, which is unchanged over the life-cycle, are not allowed to save, and receive disutility from working. The government can assess a tax on both current income and the geometric average of income over the life of the agent. In the model, a single parameter determines the extent to which taxation distorts labor supply choices, while the weights on historical income determines the degree to which taxation may allow for consumption smoothing. By restricting the model to lack a savings vessel, the author is able to solve for the intra-period allocation. This further allows policy functions to be derived to a first-order log-linear approximation.

Due to the structure of the model – specifically, the lack of savings in the model – the author is able to obtain strong analytical characterizations of the welfare-maximizing tax structure. First, the author shows that the geometric mean parameters (those that determine the weights on historical income), are set to minimize the variance of log consumption. Once history-dependent taxation is allowed, the need for progressive taxation decreases. Thus, weight on the historical level of income can be used to decrease the variance of consumption rather than changing marginal tax rates. By using history-dependent taxes in lieu of taxes on current income, the government can maintain the labor supply while

simultaneously decreasing the variance of consumption. Setting parameters of the model to standard values, the author analyzes the welfare outcomes under various tax structures. The welfare gains from replacing an optimized US tax system with one that includes history dependence is 1.77 percent, in consumption equivalence. The welfare gains from replacing the current US tax system is 2.48 percent. More than 90 percent of these gains are accrued through consumption smoothing rather than reducing the distortion on labor supply.

The audience was enthusiastic about the analytic simplicity of the model. They did, however, have concerns that removing the borrowing and savings decision limited the usefulness of the model. One audience member in particular was confused about whether history dependent taxation was simply a substitution for a savings decision. The author agreed, but argued that the tractability was also important for the problem. Along the same lines, another audience member asked if the equilibrium was implementable in a model that included a savings decision, to which the author replied that they would not be directly equivalent, but very similar. ◆

The Effect of China's Macroeconomic Policies Along the Convergence Path
Nalini Prasad

The author assesses the effect that China's capital controls have on the allocation of production globally. Since the 1990s, China has undertaken several approaches to intervene in foreign currency markets, and also have implemented policies that have caused a de facto closing of their capital account. The effect of these policies, however, has been widely debated in both economic and political circles – with the sum effect of these policies yet to be fully understood. This paper endeavors to provide an answer to this question. To do this, the author constructs a model of international trade, in which there is a home economy and a foreign economy that represents the rest of the world. Policymakers are allowed to buy and sell foreign bonds, and then trade with households, approximating the behavior seen since the 1990s. She finds that their policies have distorted global allocations by shifting production to China, while decreasing consumption in China, and investment everywhere.

The author uses a relatively standard two-country international trade model, in which a home country employs policymakers who control the foreign account, and can sell bonds to their citizens. A foreign economy is proxied by the United States. Within each country, intermediate goods are produced by monopolistic firms who employ capital and labor.

Output is a CES aggregation over intermediate goods produced by both economies. Households consume and save, and receive disutility from working. For savings, households have access to both a domestic and a foreign bond, in the baseline, whose returns are tied together by government decisions in both countries. To model the Chinese economy, access to foreign bonds is shut down as the capital account is closed. The home government then completes each foreign currency intervention by "sterilizing" its purchase – selling or buying enough domestic bonds to home citizens to precisely offset the expenditure on foreign currency.

The model is calibrated to match time series on total factor productivity growth and foreign exchange reserves. The author models the acquisition of reserves by the Chinese government by using a linear policy rule in previous period reserves, imports, and exports, estimated from the data. She employs this policy rule, and allows the exchange rate to respond. The model itself is calibrated to an annual frequency, with identical preference and elasticity parameters in both the home and foreign economy. Preference parameters are standard for a model at an annual rate, with log-utility and an annual interest rate of 4 percent. Home production parameters are set following the previous literature on China, while foreign production parameters are set to standard values. Having calibrated the model, the author explores the effect of various foreign exchange policies on aggregates. First, she shows that in the absence of capital controls, Chinese citizens smooth consumption by borrowing from the rest of the world. Along the convergence path, this drives up the price of the home good through a demand channel, and causes an appreciation of the real exchange rate. However, when capital controls are instituted, the home country essentially forces their consumers to lend to the rest of the world. This is specific to the policy in China – the government policy has been to lend to the rest of the world through currency purchases, and then to offer government bonds to citizens in order to finance these purchases. The combination is that the Chinese government "sterilizes" their current accounts, while the household increases their savings relative to the open economy case. This drives an increase in production in China, while simultaneously increasing consumption abroad.

An audience member was first concerned about whether or not people actually accede to capital controls in China. The author said that she cannot be completely sure, but the data strongly indicate that they do. Another audience member was confused about the reserve acquisition rule, noting that it seemed ad hoc. Prasad said that it is tough to endogenize every decision in the model, and one could think of it as an analog to the Taylor Rule in an international trade framework. ◆

The Chinese Saving Rate: Productivity, Old-Age Support, and Demographics
Ayse Imrohoroglu and Kai Zhao

Imrohoroglu and Zhao explore an empirical regularity that observed in China: from the 1980s to present, the Chinese national savings rate has more than doubled. Standard models have struggled to account for this regularity, so the authors explore the effects that changing demographics and old-age support systems, as well as the transition away from communism to capitalism have on the savings rate. Key to accounting for these changes is the institution of the one child policy, as well as the limited government expenditure on old-age care. With the one child policy, parents have limited ability to count on their children for support and care as they age. Similarly, the lack of institutionalized old-age care necessitates additional savings. In combination, parents from recent generations find it optimal to substantially increase their savings relative to parents from previous generations. They find that these changes are able to account for the changes observed since the 1980s in the national savings rate.

The model features overlapping generations, with prices determined competitively. A government taxes both capital and labor to finance an exogenously given stream of government consumption, with consumption transfers to balance the budget. The government also runs a pay-as-you-go social security system that is financed by a payroll tax. Children become parents deterministically, and are required to retire at a preset age. Following retirement, death is stochastic, and may occur after the birth of up to two future generations. Ability is binary (low, high), and determined at birth by a stochastic process, correlated with parent's ability. Agents face a stochastic productivity stream that trends deterministically, but is subject to AR(1) shocks. Parents face a health risk, which determines a transition from healthy to requiring long-term care. Long-term care requires a time cost as well as a goods cost. The time cost makes the one child policy expensive for families with unhealthy parents, as they must devote time to care that would otherwise be spent in the labor market. Income is calculated at the family level, as a sum of parental income (or social security), and children's income. Finally, assets are split among the children if the parent dies. In combination, both the one child policy and limited old-age support serve to strain the family's budget as parents move through old age.

The authors calibrate the model to match salient features of the economy in 1980, and then implement a set of policies corresponding that correspond to those observed. They allow agents to be "born" at age 20, and live to at most 90 years.

They are assumed to become a parent at age 55, and retire at age 60. Initially, population growth is set so that a couple has on average four children. The growth rate is then changed to reflect the one child policy, which corresponds to an average of 1.3 children per couple (rural areas can have two children if the first is a girl). Preferences are represented by power utility and production is Cobb-Douglas. Ability and income shocks are calibrated using data on high school and non-high school graduates (high and low ability, respectively). They calibrate long-term care risk to match the cross-sectional percent of elderly needing long term care in 2005, which results in a 50% probability that a parent will ever need long-term care, which is in line with the literature. The authors simulate the model by sequentially adding forms of risk to the model. They find that income risk and fiscal policy play a relatively small role (or none at all) in determining the large change in savings rates. Adding a series of TFP fluctuations allows the model to better reflect the cyclicality of the savings rates, but continues to miss the overall rise in savings. Finally, adding in long-term care risk, the model does a good job reflecting observations on the savings rate. They argue that this highlights the interaction between children as an insurance mechanism and government old-age policy.

Several members of the audience were confused about the structure of long-term care in the model. One first asked whether long-term care changed life expectancy. The first author responded that it did not, but could be thought of that way, as all in the model were required to provide it. Another audience member noted that spending 50 percent of your time providing long-term care seemed quite high, to which the first author noted that there is no Chinese data on this and that data was from US sources. Finally, two members of the audience had trouble believing that the interest rate generated by the model (which was quite high), was in accord with what was observed in the data. The first author said that she could explore lower interest rates to see if the results were robust. ◆

Privatization, Distortions, and Productivity
Kun Li

The author develops a new method to empirically extract the effects of privatization on productivity and distortions. As the Chinese economy transitioned from communist to capitalist, thousands of state-owned enterprises were transferred from government to private control. This paper explores the effect that this transference had on productivity of the aggregate economy. Because of the complexity of the economy and the simultaneous events during the same period, it is challenging to extract the extent to which privatization effected improvements in productivity and misallocation (i.e., distortions). Here, the author employs sensible identifying restrictions about the timing in the production process, which allows him to separately identify components of interest. He finds that when a firm is privatized, it immediately realizes a 5% increase in productivity, and a 12% increase overall, relative to a government run counterfactual. He also finds that it reduces distortions by 2% immediately, which results in an increase of 0.2% in revenue.

To evaluate these components, the author employs structural estimation on a relatively standard model of dynamic investment. The economy is populated by a single infinitely-lived worker, who operates in discrete time. A firm employs capital and labor, connected across periods by investment and hiring or firing decisions. They also employ materials, which are selected after realizing the shock each period and last for one period. That is, capital and labor are determined during the previous period, and not selected optimally after realizations of the idiosyncratic risk. Each period, there are two sources of idiosyncratic risk. First, there is a productivity shock that alters output and thus revenue. Second, there is a stochastic "tax" that distorts the marginal product of all inputs equally, and is not included as a rent in firm revenue. Key to identification is the careful specification of timing in the model. At the beginning of the period, a firm takes their stock of capital and laborers as given, and observes distortions in the economy. Subsequently, they choose to purchase materials, as well as capital and labor in the following period with the associated adjustment costs. This careful timing allows identification of the unobserved productivity and distortion time series.

To obtain full identification, the author makes a few additional assumptions. First, he assumes that revenue is linear in logs (as it would be in his theoretical specification). Second, he assumes that productivity follows a persistent AR(1) process (i.e., the process is not i.i.d.). Finally, he assumes that firms can observe all shocks before choosing

materials. By conditioning the expectations on each of these different information sets, he is then able to algebraically derive expressions for the technology parameters, as well as productivity and distortion shocks. For intuition, materials are the only input that respond during the period to distortionary shocks. Assuming Cobb-Douglas production, this allows the observer to discern the size of these distortions over time, as one can observe the evolution of productivity shocks through adjustments of capital and labor, but not the direct impact of distortion shocks. Taken as a whole, these assumptions allow the identification of a time series of productivity and distortions, as well as the production parameters. To extract the effect of privatization on productivity and distortions, the author calibrates these processes to feature a parameter for private as well as state-owned enterprises. Then he simulates various alternate outcomes for individual firms and the aggregate economy. He finds that privatization increased overall productivity by 14 percent, relative to a case with no privatization, but did not substantially alter distortions. He also finds that had more firms privatized earlier, productivity

would have increased by 4 percent, relative to the observed trend. Likewise, in the aggregate, privatization played a large role in determining growth, while reallocation played a smaller and perhaps inconsequential role.

Immediately members of the audience were concerned that the author was suggesting that a seminal paper in the literature on distortions, Hsieh and Klenow, was incorrect. The author argued that his paper was in fact complementary, and consistent with a concurrent paper (and equally seminal) by Restuccia and Rogerson. Another member of the audience wondered if the identification assumptions were such that the author could get over-identification and test the restrictions. The author responded that if you believed the materials were non-durable, then such a test was possible. One audience member took issue with the fact that privatization was not random, which could confound his results. The author argued that nonrandom privatization was fine, noting that the parameters were not identified from random privatization, but from the timing of production. ◆

Participants and attendees shown at the Rydges South Bank Hotel in Brisbane, Australia.

7th Advances in Macro-Finance Tepper-LAEF Conference

SEPTEMBER 23-24, 2016

CONFERENCE PARTICIPANTS

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The Missallocation of Finance
Toni Whited and Jake Zhao

It is well documented that the misallocation of capital and labor contributes significantly to total factor productivity (TFP) differences. While much of the research focused on addressing this issue is motivated by discussions of finance, few have addressed external financing directly. In their paper, the authors fill this gap by extending the empirical framework of Hsieh and Klenow (2009) to investigate potential gains from reallocating debt and equity across firms. In their model, the authors assume that firms are financed through debt and equity, and decompose the real benefit of finance derived from the proceeds of these financial assets at both the firm and sectoral level. The framework features sector and firm-specific prices, financial total factor benefits, CES aggregation of firm-specific benefits of finance within each sector, and the combination of these sectoral benefits using a Cobb-Douglas aggregator. Using Chinese manufacturing data obtained from the National Bureau of Statistics of China and Compustat data for U.S. manufacturing firms, the authors compare Chinese and American manufacturing firm value added.

Results indicate that gains from moving to an optimal allocation of debt and equity in the U.S. range from 13% to 18%. In contrast, Chinese firms stand to gain 70%-100% by moving to U.S. levels of efficiency and over 100% by moving to the optimal allocation. The authors further identify that a lack of access to finance – rather than the misallocation of the type of finance – is to blame for the large TFP losses in China. Additionally, the authors back out the firm specific prices and find that the costs of debt and equity are significantly lower for larger firms.

The discussant, Joel David, approached the author's problem using a simple analytical model and was able to replicate their empirical results. He emphasized that the authors should consider clarifying their main results using a simple analytical framework, and highlight their differences from Hsieh and Klenow (2009) more clearly. Moreover, the discussant argued that it is difficult to attribute the distortions discussed here to finance, as real distortions may manifest themselves as financial frictions. The presenter agreed that her framework does not specify the source of the frictions measured in her paper and acknowledged the need to obtain data from countries which have well-functioning financial markets but labor markets with rigidities. Like the discussant, some in the audience suggested incorporating a simple model to analytically support the results. Other concerns emanated from the method used to measure firm size and whether or not the relation between observed and optimal firm size is testable from the data. While the presenter argued this is testable by measuring firm size as the amount of observed total liabilities and comparing it to that implied by the efficient allocation, she again acknowledged her task of seeking out better data. Additionally, she anticipated obtaining a better measure of firm size from Census data in the near future. ◆

Real Anomalies
Jules H. van Binsbergen and **Christian Opp**

A large literature on asset pricing concerns itself with "anomalies" – deviations of asset price behaviors from existing model predictions. Though much has been done to reconcile some of these peculiarities, many still remain and suggest a degree of irrationality on behalf of agents. The authors take this a step further and ask what implications these mispricings have on the real economy. The idea is that agents use prices (which are subject to these anomalies) to evaluate economic decisions, and that these decisions are thus dependent on any financial distortion.

Anomalies are usually captured through the estimation of "alphas," which are the residual average returns that cannot be explained by benchmark asset pricing models. The authors point out that merely identifying these alphas does little to indicate what real impacts they will have on the economy, for three reasons. First, because these alphas measure changes in mispricing, the effects are necessarily dynamic phenomena. Next, they measure returns, so backing out the levels is key. Last, it is not straightforward how to incorporate these distortions on decisions for real investment.

In order to assess what real implications these asset pricing anomalies have, the authors construct a structural model that matches the joint dynamic distribution of firm characteristics that feed into these anomalous observations. Given this benchmark, they then compare the real outcomes with those in an otherwise similar model without the anomalies. This is contrasted with the approach usually found in the literature, namely the identification of statistically significant anomalies. Here they are concerned with whether or not these distortions are of economic significance.

A common concern with this literature is that the results are conditional on the particular asset pricing model being used. A conference participant raised the point that it is not obvious that the alphas from a CAPM model, which is what these authors utilize, necessarily mean that there is a mispricing. The second author explained that, insofar as pricing errors are necessarily conditional on the model used, this problem is unavoidable and won't invalidate their results

any more than the asset pricing literature at large. He pointed out that the authors' model is flexible such that many different asset pricing models can fit into their framework.

The authors begin their analysis with a replication of some well-known CAPM anomalies over the period 1975-2014: book-to-market, investment, profitability, and momentum. From here they construct a few measures of mispricing: a simple average, an equity-weighted average, and a value-weighted average. Next, they back out the persistence of these anomalies by estimating Markov transition matrices by looking at the movement of portfolios over time into the different deciles. These results inform the "abnormal" returns that agents have expectations over in the model.

The main feature of their structural model involves the potential for managers of firms to search for opportunities to upgrade their capital stock. They do this by choosing an expected investment (or disinvestment) rate, which governs an arrival rate for these upgrades. Managers maximize the market value of their firms, given the prices. Their investment choices depend importantly on the managers' beliefs about future cash flows and of future values of the stochastic discount factor (an evaluation about future marginal utilities), both of which can be distorted by the aforementioned anomalies.

After calibrating the model to be consistent with the literature and comparing results of an environment with mispricing to one without any, the authors find that the cross-sectional anomalies have important effects on value added and investment. The distorted cost of capital for individual firms leads to over- and under-investment, which is suboptimal and leads to "value destruction." With regard to value added, the authors find that these distortions can lead to a relatively large decline in value added, meaning that there is potential for large rent extractions from fixing these anomalies.

In his discussion of the paper, Dimitris Papanikolaou brought up the point that, in the current calibration, the sensitivity of the model is overstated when simulating a cross-section (by about a factor of ten). He points out that this issue can be partially fixed by simulating a panel, which is important in part because the paper is interested in magnitudes. It was also pointed out that it might be interesting to extend the model and explore the distortions brought about by financial policies or regulations. To this point, this research opens up many more interesting extensions, such as how these results change when interacting these distortions with agency frictions, and will be useful for evaluating the real implications of many different asset pricing puzzles. ◆

National Income Accounting When Firms Insure Workers: Understanding Firm Size and Compensation Inequality
Barney Hartman-Glaser, Hanno Lustig and Mindy Zhang

It is well documented that the aggregate capital share of publicly traded firms has increased over the last 40 years. Over the same period, idiosyncratic volatility of both firm-level cash flows and returns has increased. As it is efficient for shareholders to insure firm managers against risk, shareholders in highly productive firms capture a larger share of profits, growing firm size inequality. These facts suggest that the primary driver behind the increase in the aggregate capital share is this risk-induced increase in firm size inequality. Contrary to aggregate capital share dynamics, the average capital share has decreased. The authors develop a model that links these facts.

In the model, managers search for shareholders in a competitive labor market and create new firms upon matching. These new firms receive permanent productivity shocks and shareholders choose to cease operations at an endogenously determined threshold productivity level. Using Compustat/CRSP data from 1960-2014, the authors calibrate their model and compare its implications to key aspects of the data. The authors apply their model to an endowment economy under full and partial insurance contracts determined ex ante, and a production economy with unskilled labor. Their main results are consistent across environments. Consistent with the data, the stationary distribution of log productivity shifts to the left and the right tail becomes flatter as firm-specific volatility increases. Additionally, the right skewness and kurtosis of the log size distribution increases.

These changes occur for several reasons. First, as firm specific productivity becomes more volatile, the stationary distribution mechanically becomes more dispersed. Second, the increased volatility decreases the shareholders' shutdown threshold level of productivity. As a result, more firms survive long enough to become more productive. Furthermore, the authors' model allows for the aggregate capital share to increase while average capital share decreases with firm specific volatility. The mechanism underpinning this result relies on a selection bias. Because managerial contracts are determined ex ante, managers pay a higher ex post risk premium to shareholders in the right tail of the distribution. The fact that larger firms drive aggregates causes aggregate capital share to increase as the mass of firms in the right tail increases. Moreover, the increase in firm-specific volatility simultaneously shifts the log productivity distribution left, thereby increasing the number of firms with low capital share.

As a result, the average capital share decreases. These capital share dynamics are supported by the data. The discussant, Matthias Kehrig, argued that this paper well-documented new stylized facts that average capital share moves opposite aggregate capital share, and emphasized that firm size inequality (rather than labor compensation inequality) explains these features of the model. He suggested that the authors focus on labor share, as it displays consistent trends in both Census and Compustat data while simultaneously removing estimation issues surrounding capital shares. Further, the discussant suggested that the authors more clearly compare their proposed mechanism to competing explanations (e.g., outsourcing, intangibles, etc.). Lastly, the discussant was concerned how the model developed in this paper addresses the fact that private firms show similar capital and labor share dynamics, though without the increase in firm-level volatility.

Like the discussant, some in the audience suggested extending their model to additional managerial compensation schemes such as deferred payments and stock options. While there were few other concerns, some pointed out that the authors' model does not specify how volatility changes over time. The presenter agreed and explained that they do not use a dynamic model for volatility, rather they simply apply one-time shocks. The presenter concluded his response to the discussant by agreeing that his results may be sensitive to the compensation scheme used and that his model can easily be extended to accommodate a two-state Markov switching process for firm-level risk. ◆

Intangible Capital and Measured Productivity
Ellen McGrattan

Much macroeconomic research relies on, or uses, data on productivity. Unfortunately, observing productivity – namely, total factor productivity (TFP) – is elusive and dependent on measures of output and factor inputs. What is troubling, however, is that these measures have historically excluded investments in intangible capital, things like R&D, software, or branding. As a result, because measured GDP does not capture this other investment avenue, it is possible to observe small changes in output at the same time as increases in hours and investment. The author highlights this measurement issue and builds a model that enables the estimation of TFP that corrects for this issue using revised U.S. national account data that adds intangible capital investments to its figures.

Part of the issue with accurately observing TFP is that it is typically calculated as a residual. In order to make this calculation, some underlying functional form or structure

is needed. Existing models do not directly allow for the incorporation of intangible capital as a factor with which to calculate TFP. The author develops a rich multi-sector dynamic stochastic general equilibrium (DSGE) model to do just that. With this framework, the author uses BEA input-output tables, which contain expenditures on some intangible capital as investments, and moves other categories that are consistent with this notion of intangible capital from intermediate inputs to investments.

The basic structure of the model takes seriously the observation that firms invest heavily in these intangibles. This is to say that there is much lost if we ignore the fact that firms are "diverting" funds from tangible investments into this other category. To capture the benefits of these investments, firms in the model have access to two production technologies, for tangible goods and services (which are rival) and intangible investment goods and services (which are non-rival). The industries are linked through purchases of intermediate inputs and through investments, a feature that, coupled with both industry-specific and aggregate TFP shocks can account for fluctuations in industry and aggregate output.

A key hurdle in getting measurements for intangible investment capital stocks, an input to produce intangible investment goods and services, is the fact that it is not possible to observe it. This is problematic insofar as TFP is typically measured by imputing the series (as a residual) from observed factor inputs. To handle this, the author uses maximum likelihood techniques on BEA industry data and BLS hours data specific to intangible production in order to estimate the stochastic TFP process. The author also decomposes the variance of the estimated TFP process, which has both common and industry-specific components. The common component of TFP, surprisingly, is found to be uncorrelated (at the business cycle frequency) with the typical measures of TFP used in the literature. That is, there is evidence that the exclusion of intangibles is important when estimating TFP.

The author runs the model and compares the results – specifically, its predictions for observable variables – to a benchmark model without these added features. Interestingly, the aggregate hours series is not used in the estimation stage for the TFP process, providing a straightforward external check. The results are promising, outperforming more basic models without multiple sectors and without this focus on the importance of intangible capital. This ameliorates peculiar implications of more standard DSGE models, which require, or at least imply, a very large (and unexplained) labor wedge in order to explain the data.

During his discussion of the paper, Max Croce recommended isolating the effects of the key modeling additions: multiple sectors and intangible investments. This is to say, in respect to the performance of the model's predictions, "shut off" each of these features to see how much of the difference is bridged between the baseline model and the paper's model separately. Perhaps more fundamental, he points out that invoking intangible capital might make the classical production function specification imprecise, incomplete, or wrong, and that this research takes an important step in demonstrating just how important it is. ⋄

Horizontal and Vertical Polarization: Task-Specific Technological Change in a Multi-Sector Model
Sang Yoon Lee and **Yongseok Shin**

Since 1980, there have been three trends of changes in the sectoral, occupational and organizational structures of the U.S. economy. They include: rising employment share and wages of lower- and higher-skill occupations relative to middle-skill occupations (horizontal polarization); rising employment share and wages of managers relative to workers as a whole (vertical polarization); and rising employment share and value added share of the service sector relative to that of the manufacturing sector (structural change).

The authors develop a model that integrates the distribution of individual skills with the occupational and industrial structure in an economy to show that the faster technological progress of middle-skill worker's tasks can drive all three main types of changes at the same time.

In their model, a continuum of individuals is endowed with two types of skills: managerial talent and worker human capital. Based on the heterogeneity of skills, an individual either becomes a manager or a worker in one of three tasks. The three tasks here are the equivalent of manual, routine, and abstract tasks. They differ by way of combining human capital and physical capital in their production process. There are two sectors in the economy, each of which has all three types of tasks. The two sectors are "manufacturing" and "services," and they differ in relative intensity of using managers and three types of tasks. In each sector, a single manager uses her own skill to optimize the allocation of human capital and physical capital across three types of tasks. Aggregating the goods produced by all managers within a sector yields the total sectoral output. Final goods are produced by combining the output of both sectors. Under the assumption of competitive economy, the solution is a social planner's optimal physical capital and labor allocation across sectors that maximizes the final output.

The authors characterize the manufacturing sector as more routine-intense and less manager-intense. In this case, a relative increase in the productivity of routine tasks within a certain range can lead to the decline of routine task jobs and an increase in the employment of managers and two other types of tasks in both sectors. Also, the employment of the service sector will grow larger than that of the manufacturing sector. Assuming the productivity of routine tasks grows at a constant speed, the model implies that in the limit, routine task jobs vanish, structural change ceases, but both sectors still employ a significant amount of labor.

Lee and Shin calibrated the model to empirical time trends in census data from 1980 to 2010 with 10 tasks. The empirical exercise shows that this task-specific technological change (TSTC) model accounts for more than 90% of employment shifts at the task-level, observed sectoral TFP growth, and more than two thirds of structural change. These robust results include sector-specific technological change, which does not cause any within-sector polarization. Also, TSTC strongly correlates positively with routinization and negatively with the employment change in manual interpersonal jobs.

The discussant, Frederico Belo, pointed out that while the facts of employment polarization are well-established, wage polarization facts are not as established. The managers vs. workers wage polarization may be linked to trends in CEO compensation, which is worth attention for separate treatment. The discussant also mentioned that the calibration matched parameters to employment shares by occupations instead of occupation within each sector. While the model's fit on employment share facts is impressive, its fit on relative wage facts is more modest. This may be a result of missing ingredients in the model. Lastly, the discussant mentioned to look further into the force that drives TFP changes in medium-skill tasks. Besides the routinization index used by the authors, offshoring ability measures are a good candidate as well. As to the insight of this paper to finance studies, the discussant suggested adding uncertainty by assuming different tasks having different productivity across the states of nature, and that this may generate endogenous stochastic discount factor. The second author commented that allowing exogenous sector-specific technological change can improve the model's fit to wage facts. Also, he mentioned that in their paper, elasticity substitution among different workers of occupations is lower than typical ones used in other literature. This is because they want to match the macroeconomic fact that the occupational shares don't change that dramatically. ⋄

Rational Inattention in Hiring Decisions: An Information-based Theory of Matching Efficiency

Sushant Acharya and **Shu Lin Wee**

During recessions, it is typical to see an increased unemployment rate as workers are laid-off and firms open fewer vacancies. Indeed, during the Great Recession, the spiking unemployment rate persisted and the ratio of unemployed job seekers to job vacancies tripled. Still, employers were unable to find acceptable workers to fill job openings, suggesting a decrease in match efficiency. These facts are not consistent with the standard full information search and matching model, which predicts a muted response of employment and virtually no change in match efficiency during downturns. In their paper, the authors develop a model of match efficiency based on the link between the cost of recruitment and uncertainty over the pool of unemployed job seekers that replicates these facts.

In their model, unemployed workers with private, differential natural ability randomly search and match with firms. Upon meeting, workers are randomly assigned a private "match quality" with the firm, and firms can choose to extract information about the worker's inherent productivity and match quality through costly interviews. Once interviews are complete, firms may hire the prospective worker or choose to continue searching. Furthermore, the per-period output of a job is proportional to the inherent productivity of the worker, the match quality, and the aggregate productivity in the economy. After one period of working, the employing firm learns all information about the worker and has the option to fire the employee. Under this framework, the authors use JOLTS and CPS data to calibrate their model, and compare it to both the standard full information model and key aspects of the data.

The model not only matches key moments of the data, but also differs starkly from the standard full information model. In particular, the model predicts that a 3% drop in aggregate productivity causes an unemployment rate rise of 5% and a 4.5% decline in match efficiency. On the other hand, the full information model predicts only a 0.5% increase in the unemployment rate and virtually no change in the match efficiency. These results rely on the link between uncertainty and interview costs in the model. When aggregate productivity drops, firms find it optimal to fire all but those workers with high match quality or high ability. As a result, the composition of the unemployment pool becomes more uncertain. This uncertainty causes firms' information acquisition to become costlier. As a result, firms conduct fewer interviews, which in turn causes them to reject workers more often to avoid mistakenly hiring a low-ability or low-match-quality worker. This mechanism also speaks to the empirical finding that firm recruiting strategies change over the business cycle. In contrast to the authors' model, information is free in the standard search and matching model, causing a muted response of unemployment and match efficiency. Lastly, the authors show that the probability of a worker being hired decreases with unemployment duration in their framework, though this effect weakens during recessions.

The discussant, Ronald Wolthoff, explained that this paper presented a novel model of recruitment behavior, which greatly improves our understanding of labor market flows. He did, however, question how several of the assumptions in the model affect the results. In particular, he argued that incorporating on the job search, shifting bargaining power away from firms, and directed (rather than random) search may change the importance of the mechanism proposed here. Further, the discussant suggested that the authors discuss policy implications in the model as well as comparisons to previous models of firm recruitment. The presenter agreed that she could incorporate directed search, in which case there would be a distribution of searchers in both the unemployed pool as well as the employed – but searching – pool of workers. She further argued that while their assumption that firms have full bargaining power may be strong, the assumption is applied to both their model as well as the standard full information model. Hence, the divergence in these two models is not driven by a bargaining power channel. Some in the audience pointed out that the mechanism specified here may be more concerned with match quality than worker ability, thereby mitigating the information channel proposed in the paper. The presenter argued that firms don't care about either alone, but rather the product of the two. Despite this explanation, these concerns persisted. ◆

A Macroeconomic Model with Financially Constrained Producers and Intermediaries

Vadim Elenev, **Tim Landvoigt** and Stijn Van Nieuwerburgh

Spurred by the financial crisis and its aftermath, the connection of financial frictions or disturbances to the real economy has been of particular interest to economists. More specifically, discussion about the efficacy and consequences of macroprudential policy as it relates to the macro economy through the financial sector has been magnified. These sorts of policies are discussed in the present paper, including things such as capping the loan-to-value at origination of loans to firms or imposing minimum capital requirements for intermediaries. The authors contribute to the literature by undertaking the challenge of constructing a quantitatively successful model that incorporates distortions from financial intermediation on the real economy in good times and in bad.

In their efforts, the authors deliver a rich model that can capture the complex interplay between four major economic agents: savers, financial intermediaries, firms, and government. In doing so, they match key macroeconomic variables and asset prices in normal times and in crises, and make three novel contributions to methodology. First, they separately model firms and banks in order to highlight distortions generated by macroprudential policy that limit both how much a firm might borrow and how much a bank can lend. This is contrasted with existing models, which do not allow for this added channel of frictions between firms and banks. Next, they address the issue of bank insolvency, allowing the intermediaries to default optimally in a manner similar to what is observed in reality. This opens up opportunities for constrained banks with limited liability to default and generate real economic effects. Last, they endogenize the risk-free rate, which is typically assumed to be constant by assuming risk neutral savers. Relaxing this assumption to (more reasonably) capture aversion to risk, they find that certain results are much different compared to the literature – for example, in regards to prices.

In this environment, savers supply labor to earn income which can be consumed or spent on short term bonds with a borrowing constraint. Intermediaries connect savers with firms, with the lending and capital constraints noted earlier. These provide macroprudential parameters which the government can change. Various shocks (e.g., to TFP and depreciation) might make bankruptcy optimal. In such a scenario, the remaining assets and liabilities are liquidated and they incur a penalty. These banks also pay for deposit insurance to the government in proportion to the short term bonds issued to savers. Firms receive financing from banks to assist in production of a market good. The government receives income from labor taxes, corporate profit taxes, and deposit insurance. It spends money on bailouts and on general government transfers and services, which are valued by other agents.

This complex model is calibrated at an annual frequency. Doing so requires the use of a new solution technique that solves for a set of nonlinear equations – in contrast to existing methods which solve and linearize around steady states. A simulation is able to match numerous macro quantities and generates amplification of persistence in trends for GDP compared to TFP. In addition, the model also is able to match a number of financial variables and prices – for example, the price of capital, bond yields, and credit spreads. Macroprudential analysis reveals that policies which limit leverage reduce welfare because the added stability is outweighed by a loss of economic activity.

The deadweight losses associated with financial recessions are larger than those of real recessions. Because of the complexity of the model, Aubhik Khan recommended tinkering with rebating these losses in order to better isolate the effects of financial shocks and TFP shocks. In his discussion, he also pointed out that the corporate tax rate calibration seemed relatively low, though he understands that this is a conventional figure in the literature, that it might be interesting to do some sensitivity analysis by increasing it. In sum, while this model is not perfect and overstates certain price effects, this rich quantitative setting is very promising for the future of quantitative analyses. ◆

A Theory of Credit Scoring and the Competitive Pricing of Default Risk

Satyajit Chatterjee, Dean Corbae, Kyle Dempsey and Jose-Victor Rios-Rull

The benefits of bankruptcy for consumers include that it provides protection to debtors from creditors at a relatively low cost. Also, future creditors are not obliged to punish bankruptcy. However, filing for bankruptcy also triggers significantly lower credit scores which results in more limited and costlier credit afterwards. In this paper, the authors investigated the motive for why debtors choose repayment over bankruptcy. The authors proposed a reputation-based theory to replicate key patterns in the U.S. unsecured credit market. The basic idea is that although lenders do not observe debtors' likelihood to default directly, the history of excessive borrowing and bankruptcy is a signal for high default propensity for the future. The reputation effect may cause people be less opportunistic, thus sustaining the credit market.

In their model, individuals differ by time discount factors in their preferences, which make some more prone to default. These privately observed discount factors evolve over time with both a persistent part and a transitory part. In each period, individuals receive stochastic earnings, make the decision whether to default at this point or not, and choose their asset positions for next period. If an individual decides to default, they face temporary exclusion of saving for the next period and can only consume a portion of their total assets this period. On the other side of the market are risk-neutral, perfectly competitive intermediaries that give loans to consumers with an endogenous interest rate. They require a spread to cover intermediation costs. In each period, intermediaries observe the earnings, assets positions, default decisions, and future asset choices of individuals – but not their preferences. To correctly price the loan, intermediaries form prior beliefs of individual's preference types and update the Bayesian posterior with new information in each period. In this framework, loan prices are assessed repayment probability using both the type score and decision rules of intermediaries.

In the data exercise, the model is calibrated to key credit market moments. In data, credit scores are used as an index of repayment probability, to match an individual's average repayment probability conditional on taking on debt of various sizes in the model. The calibration results show that default behavior by credit score closely matches data. Asymmetric information expands the fraction of economy in debt but reduces welfare relative to full information. Reputation matters in a way that many borrowers would require significant compensation to be labeled as the type more prone to default. Also, the impact of dynamic enforcement on equilibrium appears modest in the simulation.

The discussant, Eric Young, expressed that the paper did a good job in fitting the cross-section of default rates by score. He recommended the authors further investigate whether the model can match more key moments such as relative interest rates and the cross-section of debt by score, because these moments can potentially affect the value of information in the model. As to policy implications, the discussant pointed out that if the costs of default get larger, information in the form of reputation becomes less valuable. He would like to see whether this model can show this effect and deduce the optimal amount of default cost. At last, Young mentioned that the actual market only keeps the default records of borrowers for 10 years. If defaults are recorded for a finite time in this model, he wondered whether the results can match the rise in scores at the removal of records. The authors said they believe the policy questions mentioned by the discussant can be investigated and replicated in this model.

One discussant mentioned that with independent shocks both in preference and income process, the consumption pattern may be excessively volatile in the model. The first author argued that the specification is justifiable by data because the actual household consumption patterns indeed have a great deal of noise that cannot be explained. Further, one of the main reasons to assume i.i.d. shocks in the model is to reduce the computation burden in dynamic programming. ◆

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