LAEF
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UC SANTA BARBARA

Volume XII
No. 3
Summer 2018

FROM THE LAB

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conference held August 2018

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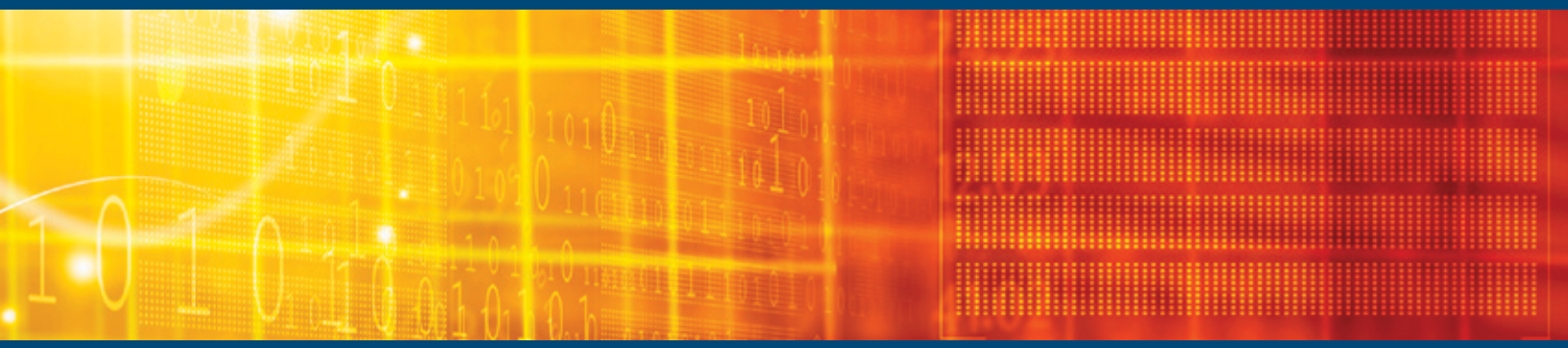
FROM THE LAB



Director's Message

Finn Kydland

This issue reports on two LAEF conferences, our second Lab-Coat conference, and our fifth annual macroeconomics and business CYCLE conference. As probably not every economist in the world is familiar with the lab-coat society, short for Minnesota Economics Science Lab, here's the history of its origination, as related by Tim Kehoe:

> *The Minnesota Economics Science Lab was founded in December 1988. Finn Kydland was finishing a year as a Visiting Scholar in the Research Department of the Federal Reserve Bank of Minneapolis. While at the Minneapolis Fed, Finn worked intensively with David Backus and Patrick Kehoe in developing the theory and data measurement of international real business cycle models. They subsequently published their scientific findings in such outlets as the* Journal of Political Economy, *the* Minneapolis Fed Quarterly Review, *the* American Economic Review, *and the famous Cooley volume,* Frontiers of Business Cycle Research.
>
> *Working on developing real business cycle models required intensive analytical and computational work at the Minneapolis Fed, which Finn, David, and Patrick came to refer to as the Lab. As the senior member of the team, Finn was referred to as the Chief Scientist. After long days of intensive work, they would often take a break before retiring for the night to meet their friends and fellow economic scientists, Tim Kehoe, Ed Prescott, and Victor Rios-Rull, to discuss economics research over a beer or two while occasionally playing a game of foosball.*
>
> *At the end of Finn's very productive stay in Minneapolis, David, Patrick, Tim, Ed, and Victor invited him to dinner at Hosteria Fiorentina, then an excellent restaurant in Minneapolis. At the request of the others, Tim purchased lab coats and name tags, and, at the end of the meal, these were distributed and the Minnesota Economics Science Lab was formally constituted by its six founding members, Finn, David, Patrick, Tim, Ed, and Victor. Finn was elected Chief Scientist and Tim was elected Grand Poobah because of his ability to fulfill much the same role as the character with that title in the Loyal Order of Water Buffaloes in the* Flintstones.
>
> *Over time, the composition of the membership in the Minnesota Economics Science Lab has changed. We tragically lost Dave Backus in 2016. We have also recruited new members to the Lab. Every new member inducted into the Lab has to show the same qualities of intensity and enthusiasm about scientific research in economics accompanied by an eagerness to discuss this research over a beer or two while occasionally playing a game of foosball.*

Personally, I still remember vividly the six of us having dinner at the fancy restaurant downtown Minneapolis, all of us wearing our newly acquired white lab coats. Other guests would come up to us and ask who are you? Are you doctors? No, we would answer proudly, we're scientists!

During my first year at UCSB, having first arrived in August 2004, our Chancellor generously offered to fund a conference, as I understood it, in honor of my having moved to UCSB permanently. While over the years since 1988 inauguration of new lab-coat members had taken place in various locations (including twice in Spain) on occasions when we could get a critical mass of members together, this seemed to me a perfect opportunity for our first official lab-coat conference. As Chancellor Yang eventually ensured the financing to make LAEF permanent, this lab-coat conference, taking place in May 2005, at the same time turned into the very first LAEF conference (whose program can be seen on our Web site).

Moving forward to 2018, over a dozen years had passed since that lab-coat conference, so the Grand Poobah and I decided the time had come for another one. Most of the existing members attended, and as a result, we now have three new members: Fabrizio Perri, our own Peter Rupert, and Gianluca Violante, for a total of 16. All three of them presented a paper, summarized in this issue along with a few additional presented papers by volunteering lab-coat members.

It belongs to the story that another member was scheduled to be inducted. To go back in history, in the mid-1990s, the Federal Reserve Bank of Minneapolis organized a conference on the 25th anniversary of Bob Lucas's path-breaking paper "Expectations and the Neutrality of Money," which, along with his paper "Econometric Policy Evaluation: A Critique," spurred the revolution in macroeconomic modelling that took place subsequently. (For more on that, see my director's message on the occasion of our anniversary conference for the so-called Cooley volume, in the Winter 2018 issue of "From the Lab.") At some point during cocktails before the conference dinner, Tom Sargent gets up and gives a beautiful laudatory speech in which he commends Lucas for having accomplished everything imaginable in the profession. But, he said, the most important honor had still eluded him: membership in the Minnesota Economics Science Lab. (Tom himself has always been perhaps the proudest member!) At that very moment, Randy Wright's phone happens to ring in his briefcase. Randy answers, returns to the group, and announces: "The vote just came in–not at this time."

Of course, the reason we all thought this was hilarious was, we all knew that, from a scientific standpoint, Bob Lucas would blow the hats off of everyone present. I personally had observed him several times engaging in conversations about research over a beer or two. Missing, however, were stints at the foosball table. That being as it may, before this last lab-coat conference, the Grand Poobah and I decided the time had come! So Bob Lucas was to be inducted along with the other three. Unfortunately, a health issue intervened, so that Bob had to cancel at the last minute. (For various reasons, it's important that the candidate be present at his or her induction dinner.) Next time, Bob!

The annual macroeconomics and business CYCLE conference, always organized by Carlos Garriga, Federal Reserve Bank of St. Louis, and LAEF's Peter Rupert, runs over four days, with sessions each day from 8:30 to 1:15. Having been served a bag lunch during the last session, most participants then get on bikes, either on relatively challenging roads in the mountains next to Santa Barbara, or, for those who prefer, opting for flatter roads closer to the ocean. I say "most participants," as I myself refuse to join in bike riding on these trafficked roads, regarding it as way too dangerous, unless, of course, I have an engine under my seat. (I own a Ducati 748.)

One goal at LAEF is to put on extremely focused conferences in the expectation that, during the conference, significant progress can be made at the conference on an important outstanding scientific question or two. At the CYCLE conferences, each four-paper session tends to have a clear focus. For the conference summarized in this issue, these topics were: Macroeconomics and Long-Run Trends; Macroeconomics and Taxation; Inflation, Nominal Assets, and Monetary Policy; Finance and Macro; and Labor Markets, Earnings, and the Macroeconomy. Enjoy the reading!

2nd Lab Coat Workshop

August 3–4, 2018

Javier Birchenall – UC Santa Barbara
Henning Bohn – UC Santa Barbara
Tom Cooley – New York University
Ted Frech – UC Santa Barbara
Gary Hansen – UC Los Angeles
Ayse Imrohoroglu – University of Southern California
Timothy Kehoe – University of Minnesota
Finn Kydland – UC Santa Barbara
Ellen McGrattan – FRB of Minneapolis
Lee Ohanian – UC Los Angeles
Fabrizio Perri – FRB of Minneapolis
Edward Prescott – Arizona State University
Richard Rogerson – Princeton University
Ray Riezman – University of Iowa
Peter Rupert – UC Santa Barbara
Gianluca Violante – Princeton University
Randall Wright – University of Wisconsin-Madison

Optimal Age Dependent Taxation

Jonathan Heathcote, Kjetil Storesletten, and **Gianluca Violante**

The authors investigate the optimal level of tax progressivity in a system that allows taxes to vary with age. The tax-transfer system they use in their paper comes from Heathcote, Storesletten, and Violante (2017). They use this tax and transfer system because it is tractable and has been shown to approximate the U.S. tax system. This parametric class includes two important parameters $\tau\lambda$. One parameter τ measures the level of progressivity while the other l accounts for the level of taxation. The important distinction in this paper is that the authors allow τ the λ to vary with age.

The authors take a Ramsey approach by using an overlapping generations model. In this model, agents value consumption, leisure, and a public good. They are ex-ante heterogeneous in their disutility of work and learning ability. In their youth, the agents make an irreversible skill investment decision. In each year of their working life, they make a labor-leisure decision. There are permanent wage shocks that occur during working life, and agents cannot fully insure against them privately because of the lack of inter-temporal trade. While the inability to insure against risk is a limitation of the baseline model, the authors will later introduce borrowing as an extension.

The authors can solve for a steady state and can qualitatively analyze the conditions for age invariant progressivity. These cases include when there is no skill investment or discounting, there is a flat profile of either insurable or uninsurable productivity dispersion, or there is a flat profile of average efficiency and disutility from work.

The authors find that given any profile for progressivity, whether it varies with age, the optimal level of taxation will equate average consumption by age. They can identify the important channels affecting the level of progressivity, including discounting, insurable risk, uninsurable risk, and efficiency net disutility of work. These different channels give the tax progressivity profile its shape and are counteracting forces.

Then, the authors use data from the U.S. to parameterize and calibrate the model. This leads them to find a U-shaped tax progressivity profile with age. Finally, they extend the baseline model by adding inter-temporal borrowing and lending. They do this by adding non-contingent bonds in zero net supply subject to a credit limit and remove the insurable productivity shocks. Using the U.S. borrowing limit, calculated with SCF 2013 data, the optimal tax profile is very similar to that with no borrowing. Using the natural borrowing limit, the optimal tax profile is much flatter.

It is important to note that in this paper; the authors use equal welfare weights. An audience member asked during the presentation why this was used, and Violante noted that this allows for a useful benchmark since changing the welfare weights is an easy extension. An audience member asked about how the model in this paper would interact with women's strategic labor-fertility decision. Violante acknowledged that they had not yet investigated this, but that it is possible to add a choice variable to the model to understand this interaction.

Unequal Growth

Francesco Lippi and **Fabrizio Perri**

Over the past 50 years, the U.S. economy has seen two major changes. Household income inequality has grown and aggregate growth has slowed down. The goal of this paper is to establish an empirical and theoretical link between these two phenomena.

First, the authors take a micro viewpoint with data from the CPS and PSID to analyze what is happening at the household level. By looking at a cross-sectional view, taxable household income has grown far more for rich households than poor households from 1967 to 2014. Households are diverging in income and the distribution is spreading out. It is important to look at a panel view to understand how individual households evolve. This view shows that poor households' income grows faster than rich households'. Growth at the bottom of the distribution would suggest convergence of income or mean reversion. The authors attempt to reconcile how both convergence and divergence occur at the same time and how these micro changes interact with aggregate growth.

The authors decompose aggregate growth into several pieces which they will later empirically estimate. This decomposition is purely statistical. The first two pieces of aggregate growth are 1) the covariance between individual income growth and relative

income shares and 2) the mean growth for all individuals. These two components add together to create total aggregate growth. The covariance can be broken down even further into the correlation multiplied by the variances of income shares and variance of income growth. Identifying these different factors affecting aggregate growth helps the authors identify the relationship between growing income inequality and the slowdown in aggregate growth.

The authors then turn toward the data to estimate the respective parts of aggregate growth. Using PSID data from 1967 to 2014, they aggregate households by income decile. This helps to minimize issues from measurement error. Then, the authors calculate the covariance of growth and shares and the overall mean across time. They find that while the mean is positive and grows a little; the covariance is negative and declines over the sample period. Thus, aggregate growth declines across the sample period.

To analyze what is causing the covariance of shares and growth to be negative and declining, the authors break it down into the variance of shares, variance of growth, and correlation between the two. They uncover that the high variance in shares has been positive and increasing over time, the variance in growth has mostly remained constant, and the correlation has been negative and attenuating over time. Thus, the growth of income inequality and the negative correlation between growth and shares combine to drag down aggregate growth.

The authors put forth a simple model to match the findings from the data. In this model, income is produced by successful projects and jobs. New projects grow and die at fixed rates, and the income from successful projects grows at a fixed rate. Some fraction of agents go without projects and have a fixed unemployment income.

To match the dynamics found in the data with the model, the authors find the steady state and then analyze three scenarios. First, they look at whether making it more difficult to succeed will produce the desired dynamics. Growth and covariance fall, but inequality rises too little, so it concentrates the fall in growth at the bottom. Next, they try to add in that new projects grow faster. Inequality increases to match the data, but it still concentrates the fall in growth at the bottom. Finally, the authors add a gradual fall in the unemployment income. At last, they find a distribution that matches the growth shares in the data.

One audience member asked whether it is a problem they censor PSID data and does not contain the top of the income distribution. Perri said this is not a problem since these people do not contribute as much to aggregate growth as one might expect, which he can confirm using NIPA data. It concerned other audience members about the large growth at the bottom of the income distribution being driven by young people, but Perri notes that the average age at the bottom is around 42 and these fast growers are just people getting the positive shocks.

On-The-Job Leisure

Christine Braun, Travis Cyronek, and **Peter Rupert**

Labor productivity is defined as the total output divided by total hours of labor. As an economy's labor productivity grows, it produces more goods and services for the same amount of relative work. Labor productivity in the United States has been increasing for over a century now and the increase continues still today, while its growth rate has been decreasing since around 2004. The authors propose an explanation for the decline in the growth rate of productivity, the existence of mismeasurement in actual hours of work because of workplace distractions. According to their calibration results based on the model, the mismeasurement in work hours may account for up to 25% of the slowdown in labor productivity.

The authors define the time workers spend on distractions during work hour as on-the-job leisure (OJL), and consider distraction sources cell phones, apps, computer peripherals, etc., for which they use technology patent data as a proxy. Observing the coincidence of rapid increase in the number of technology patents and a slowdown in the US labor productivity, they try to answer to what extent OJL may account for the decline in the growth rate of labor productivity and compensation. They study the problem using a model of technological change and imperfect monitoring within a search and matching framework, where worker and firm bargain over wage and hours of work with both parties taking into the consideration of the possible OJL, and given the wage level, a worker chooses optimal OJL, with the potential risk of being separated from the job.

Increase in technology may increase the labor productivity as we would usually expect, while according to the authors' perspective, it may also increase the chance of workers taking leisure during the work hours, and thus overestimate actual hours of

work, underestimate the productivity and further underestimate the actual labor compensation. The productivity if measured according to the actual hours of work by taking into account of OJL should be higher than the one currently measured. This also infers that productivity may not have slowed down by as much as what they predicted but that it has become more difficult to measure.

During the discussion of the research, several questions were raised. First, OJL might have existed in the past, why did it not affect the growth of productivity by then but now? The reason as the presenter and one discussant suggested could be that back in time OJL was more physical, easier to be detected, while now as technology develops, the chance of taking OJL is higher because of the easier access to the distraction sources while the chance of being caught is relatively low, hence OJL may affect productivity more than in the past. Second, they discussed similarity of the OJL model with two other classic models, one to be the job-leisure substitution model, and the other to be the shirking model where workers can either work or shirk, choosing their effort levels. As the presenter addressed the differences and comments added by several discussants, OJL model differs from the job-leisure substitution model in that workers do not decide about the total time they want to take as leisure, instead workers make leisure choice as the chances of leisure come randomly throughout their work time, and so the model will not suggest total efficiency work hour level compared to job-leisure substitution model. OJL model differs from shirking model in the sense that, workers do not get to choose work effort level and the wage is not either an incentivizing tool for them to make more effort, to shirk or not does not imply the level of OJL. Third, discussions have also gone extensively on how to account for OJL from the American Time Use Survey (ATUS) data to make a better prediction of its effect on productivity and labor compensation that are surveyed by BLS based on recorded working hours.

The Effects of Monetary Policy and Other Announcements in Dynamic General Equilibrium

Chao Gu, Han Han, and **Randall Wright**

Randall Wright and coauthors analyze the effect of news in economies where assets provide liquidity. They use a general equilibrium model where agents explicitly search for exchanges with each other or the so-called New Monetarism. They find that dynamic impacts can be intricate. Their dynamics do not come from multiple equilibria; they start with a well-established single equilibrium in a two specific dates. News about real factors, like productivity, or monetary policy decisions can generate cyclic and boom-bust responses. Central bank announcements might increase volatility and reduce welfare.

The authors consider a version of the rational expectations framework. In this paper, the rational expectations hypothesis is that "one should not model repeated changes as repeatedly unanticipated." In their framework, there are two main dates an event date and an announcement date. Events happen at the event date, while announcements or news happens in the announcement date, which should be before the event date. In doing so, they can capture both unexpected events, when the announcement date never arrives, and perfect foresight, when the announcement date is in the infinite past, as special cases.

To construct dynamics of announcements of future events, they use backward induction to specify transitions from the announcement date to the event date. The trajectory can imply run-ups, crashes, and oscillations in prices and quantities. Even news of neutral, temporary policies in the short run might induce such elaborate dynamics. This finding contradicts the classical view that money interventions are neutral if and only if expected. It also implies that Fed announcements of money injections may generate nonneutral responses in markets.

Traditionally, common policy practice thinks forward guidance reduces volatility. The authors find evidence that news announcements by the monetary authority can increase volatility. Further, they find evidence that the induced volatility can be welfare improving. However, exploiting forward guidance is sensitive to parameters values and timing so it might be unmanageable in practice. Even the lack of announcements might propel such complicated dynamics, primarily, if agents have expected something.

They use a myriad of models to construct the transitions to information shocks at the announcement date to the event date. First, they use overlapping generations (OLG) and cash-in-advance (CIA) models of fiat money. Second, they analyze transitions in search-based models that accommodate multiple fiat monies, real assets, secured credit, and combinations. Third, they

include unsecured credit to show that liquidity matters, not money. They consider news about real factors, like productivity or credit conditions, and monetary factors, like neutral and nonneutral policy changes.

Their model offers counterexamples to previous literature predicting that early announcements reduce volatility. The authors argue that liquidity introduces significant nonlinearities, which previous literature did not recognize. Likewise, they provide counterexamples to previous literature that suggested that it is best to reveal good news early and lousy news late. For instance, it's good to announce a monetary injection in advance.

Wright and coauthors point out that multiple and staggered announcements induce dynamics that are even more intricate. It is true whether the news is a value of the policy rate not in the priors' support or a particular realization of the policy. Regarding quantitative easing, news of future decreases in the policy rate temper the effects of current increases. Beneficial effects of quantitative easing arise mainly from decreasing the policy rate in the long run term and not increasing it in the short run.

The authors claim it is hard to see the quantity equation, e.g., neutrality in the data even when it is correct by construction.

The audience was concerned with the parameters values in the quantitative analysis. For instance, the discount rate and the money growth rate, which is the policy measure, are set to deliver real annual interest and inflation rates of 5%, which seemed to be high for some members of the audience. Although the authors do not calibrate the models, they mentioned that they use realistic parameters.

Sweat Equity in U.S. Private Business

Anmol Bhandari and **Ellen McGrattan**

The authors provide evidence that existing measures of business incomes and valuations based on widely used surveys such as the Survey of Consumer Finances (SCF) are mis-measured. For example, they find that the panel study of income dynamics (PSID) underestimates and the SCF overestimates certain business sub-categories, such as dividend yield. This paper then develops a theory disciplined by U.S. national accounts and business census data to measure net incomes and private business sweat equity—which is the value of time to build customer bases, client lists, and other intangible assets. The motivation for studying sweat equity comes from the fact that private business has few owners bear substantial risks, and as a result, sweat equity is the key for business activities. For instance, 60 percent of private business is being exchanged are turned intangible.

The authors consider two types of firms: C-corporation (large public firms) and S-corporation (small private firms). To do so, they implement two key features in the model to distinguish public and private firms: taxation and underlying assets of the business. Using a general equilibrium model with heterogenous agents, the authors first ensure that key parameters of their baseline model are consistent with U.S. national account data, IRS data, and U.S. Census data. Based on these specifications, they estimate an aggregate sweat equity value of 0.65 times GDP, with little cross-sectional dispersion in valuations when compared to business net incomes and a large cross-sectional dispersion in rates of return.

This paper investigates whether sweat equity might impact recent tax reforms, considering a 50 percent of business income are contributed by the top 1 percent income group. The authors subsequently estimate the impact of tax policy changes on the sweat equity valuations and other key economic aggregate. For example, by lowering business tax rates 10 percentage points, the authors find that wages and GDP are higher by 5 percent, C-corporations output subject to corporate income taxation are higher by 6.5 percent, private business output are higher by 9 percent, and sweat equity are higher by 6 percent. They associate a 10 percent point decline in the tax rate on profits with a 2.8 percent rise of corporation hours, which is due primarily to individuals switching between sectors and has not found by previous literatures.

Overall, the authors find that sweat equity is large and roughly as valuable for businesses as fixed assets. Dr. McGrattan further adds that a model without sweat equity would lead to a wrong answer. In terms of the predictions about the impact of tax policy changes, they find that changes in aggregate outcomes contribute to intensive margin for young business, the choice of hours, saving, and production conditional on the occupation choice, as it accounts for roughly 55 percent of the total changes. The authors further consider two robustness checks: one is to extend their model with nonpecuniary benefits and the other is to consider a life-cycle model, both of which provide similar quantitative results as compared to their baseline model. Dr. McGrattan concludes that their main results are robust to different variations.

The United States Has a Trade Surplus and a Large Net Asset Position

Edward Prescott

Prescott argues that the current U.S. accounts are unbelievable. For instance, the 2014 benchmark survey from the U.S. Direct Investment Abroad (USDIA) reports that 13% of U.S. multinational assets are invested abroad, and 40% of their profits come from these investments. They imply that taken averages across investments, the return on U.S. direct foreign investment (DFI) averaged 9% from 1982 to 2006, whereas the return on direct foreign investment in the U.S. was 3% on average. He states that the reason for the difference in returns is not the incompetence of foreign investors.

The author points out that the accounts report the U.S. went deep into debt since 1980 and, simultaneously; they report that earnings on the U.S. net asset position have increased. For instance, the accounts report that the U.S. net asset position is now -0.45 annual gross national product (GNP), whereas it was zero in the mid-1980s. They also say during 1984-2014, the U.S. net foreign investment income increased. The author finds these two facts implausible.

Prescott concludes that the current U.S. accounts are not believable. He then gives alternative accounts that are believable. In particular, he uses GNP accounts. There are three main differences between the current accounting system of U.S. external accounts and his proposed system. First, the author considers that the U.S. foreign factor incomes as net exports. Second, he classifies the U.S. payments to foreign factors used in the U.S. as imports. Third, the U.S. receipts for its factors used abroad are exports. In other respects, the gross domestic product (GDP) and GNP accounts are the same.

He argues that the revised accounting system is not new. It is the way they initially conceived the U.S. national accounts incomes back in 1947. In this system, savings are equal to investment. Besides, GNP is the income concept that best matches aggregate economic theory. The revised accounts use both the neoclassical capital growth theory and the theory of national accounts. In the revised accounts, all accounting identities hold, and there is internal consistency.

The author constructs a new series of net asset position using its law of motion. That is to say, the law of motion for net asset position tells that the future net asset position equals the sum of the current net asset position, the average return on those assets, net exports and net transfers received in the current period. He assumes that investments abroad earn a real annual return of 4.2%, which has been approximately the average business sector's real return rate on tangible capital investment. Using the reported net exports and net transfers and taking 1970 as the base year, he can back up a revised net asset position series.

The new accounts impute services to consumer durables similar to the treatment of residential real estate owned and used by the owning household. They treat the purchases of as part of the private domestic investment. In doing so, the revised accounts impute the services of consumer durables using the assumption on the real annual return (4.2%). Then, the net rental income of consumer durables adds to the income of capital, and the depreciation of consumer durables adds to depreciation. This method results in income and cost being equal to the value of final product sales.

Finally, the author assumes that the services of government capital are equal to the sum of its depreciation and a 4.2% real return. The existing accounting practice assumes that the real return rate is zero for this purpose. Therefore, the government production and product must increase by 4.2% of the stock of government capital.

Kaldor's growth facts hold for the revised accounts. For instance, the growth facts are the relative constancy of the capital-output ratio, the investment and consumption shares of output, the capital and labor shares of income, and the constant real growth rate in living standards. These facts imply that the real return on capital is constant.

There are some remaining areas of research. First, the handling of property rights is bothersome. Second, traditional national accounts do not report capital gains, so it is difficult to classify them. Third, the revised accounts still do not account for terms of trade, money, and foreign exchange. The audience questioned that the revised accounts still have measurement error and depend on specific assets, that might not be constant across time, and that some assumptions are not strong enough.

Household Saving, Financial Constraints, and the Current Account in China

Ayse Imrohoroglu and Kai Zhao

The sharp increase in current account surplus in China around 2007 is surprising since the time corresponds to a period of high growth rates, a high return to capital, and high investment rates. The literature explains the increase in current account surplus around 2004-2008 and the decrease around 2008 either by a rise in savings rate, a rise in corporate savings, household credit constraints or changes in investment rates. However, these explanations can account for the increase in the CA surplus before 2008 or the decrease afterwards, but not both.

Imrohoroglu and Zhao construct a general equilibrium model by accounting for both saving and investment behaviors that lead to the changes in current account in China. The model incorporates overlapping generations of altruistic households where parent and children insure each other against labor income risk when young and old age health risk by pooling resources in the household. Old age risks and the decline in family insurance because of one child policy lead households to save.

Entrepreneurial families own firms that face financial constraints. Firms can finance investment by their own capital and a limited amount of external funds from the banking sector which is modeled as a limited pledgeability constraint with a time-varying repayment rate. They calibrate the borrowing constraints to match the external funding the Chinese firms use.

The model performs well to match the Chinese data both in the steady states before and after opening the economy, and along the transition path, in particular the data since 1990 for current account, gross saving rate and gross investment rate. The authors then proceed with a decomposition of sources of change in current account. To examine the role of one-child policy, a counterfactual analysis in which the one-child policy is never implemented shows that the current account balance would be substantially lower during the entire period and the rise in 2000 would be much smaller. The channel is that without the policy, the households would have more children which means a higher family insurance and lower savings rate. To assess the role of relaxation of financial constraints after 2008, a counterfactual case in which the repayment rate in the constraint is held constant at 2008 level. This case reveals that the current account would have continued at historically high levels if the constraint has not been relaxed. To assess the tightening of the constraints in the late 1990s, the value of repayment rate is held at its 1997 level between 1997 and 2008. This exercise reveals that the current account surplus after 1997 would have been much lower because of higher investment rates during the period.

One participant asked why they don't have other expenditures such as education and the housing market. Prof. Imrohoroglu answered that education is another story and there are enough studies showing that housing prices are not the story for the savings rate in China. Another participant commented on one of their assumptions that is the consumption floor, if they didn't have consumption floor in the model, the households would go crazy in saving. Prof. Imrohoroglu pointed that calibrating that parameter is crucial and is difficult. There are estimates for the consumption floor for the U.S. which has been a benchmark for them in the paper.

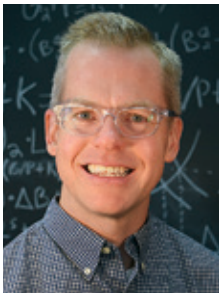
5th Macroeconomics and Business Cycle

August 8-11, 2018

Arpad Abraham – EUI, Florence
R. Anton Braun – FRB of Atlanta
Juan Carlos Conesa – Stony Brook University
Paul Gaggl – University of North Carolina Charlotte
Carlos Garriga – FRB of St. Louis
Aspen Gorry – Clemson University
Grace Weishi Gu – UC Santa Cruz
Marcus Hagedorn – University of Oslo, CEPR
Roozbeh Hosseini – University of Georgia
Sewon Hur – University of Pittsburgh
Marek Kapicka – CERGE-EI
Paul Klein – Stockholm University
Finn Kydland – UC Santa Barbara
Gabriel S. Lee – University of Regensburg
Alessandro Mennuni – University of Southampton
Abdoulaye Ndiaye – Northwestern University
Peter Rupert – UC Santa Barbara
Todd Schoellman – FRB of Minneapolis
Immo Schott – University of Montreal, CIREQ
Vincent Sterk – University of College London
Johannes Strobel – Simon Fraser University
Gustavo Ventura – Arizona State University
Noah Williams – University of Wisconsin Madison
Fang Yang – Louisiana State University
Carlos Zarazaga – FRB of Dallas

Capital and Productivity in U.S. States

Joel McMurray and **Noah Williams**



The focus of the paper is on state-level growth during the period 1970-2015. The main contribution is the construction of a new series of state-level capital stocks using data on the aggregate capital stock and payments to capital at the state and industry level published by the Bureau of Economic Analysis (BEA). The authors estimate state-level capital within an industry by allocating nationwide capital in that industry across states in accordance to restrictions given by Neoclassical theory. This "top-down" approach differs from the standard perpetual inventory method, but this approach is necessary as no statistical agency publishes estimates of investment at the state and industry level.

The authors use the constructed state-level capital series to study growth experiences of the states between 1970 and 2015. They find substantial heterogeneity across states and regions in their growth experiences. For the entire United States, output grew at 2.8% on average over this period, with capital accumulation accounting for 31%, labor 41%, and TFP 27%. The Southwest was the fastest growing region in the United States, with a 4.1% average growth rate. Its decomposition was very similar to the US, and it experienced more rapid growth in each factor. However, the Rocky Mountain region also had relative rapid growth at 4%, but with a larger 46% of it driven by labor. In the relatively slower growing Mideast, total factor productivity accounted for 36%, the largest growth share among regions, of its more modest 2.2% growth. At the state level, Louisiana had one of the most extreme experiences, with a net fall in capital over the period, and TFP accounting for 62% of state-level growth.

The authors also document that the overall capital's share rise from 0.31 to 0.42 from 1970 to 2015 in the United States. However, this trend has not been uniform across states or regions. Overall, all the BEA regions and 49 of the 50 states (all except New Mexico) experienced an increase in capital's share over the sample, but the magnitude varied. Besides the overall increase in capital's share there has been geographic convergence: on average states that had lower capital's shares in 1970 experienced larger increases over the following years. There have been very different time trends across industries, with labor's share falling substantially in manufacturing but exploding in services.

The authors also decompose state TFP growth into a component that captures growth within industries and one that characterizes productivity growth because of factor reallocation towards more productive industries. They find that for most states, growth is because of within industry productivity growth as opposed to reallocation. Regions contributed to productivity growth by reallocating factors toward more productive states.

One audience member asked whether NIPA has data on investment flow. The author noted that it only has data on investment return. Another audience member asked whether the construction takes into account differences in state policies. The author remarked that the current construction equates marginal productivity across states and does not include state policy such as tax. The audience member noted that the difference in state level policy is absorbed by the TFP factor. One audience member asked how the authors deflate output. The author replied that they use quantity chained weighted index at the state level to deflate output.

The Effects of Technological Change: Does Capital Aggregation Matter?

Maya Eden and **Paul Gaggl**

The authors explain how the price of information and communication technology (ICT) investment is one factor that explain the declining labor share in the last 30 years. They reinterpret the Karabarbounis-Neiman's regression to calibrate elasticities with a capital disaggregated into ICT and non-ICT. They point out that the method to aggregate capital matters for conclusions about the labor share. In a quantitative application, automation can explain a falling labor share even with a constant capital price. They conclude that the elasticity of substitution is not a sufficient statistic to gauge effects on the labor share and output.

In a first contribution, they document declining labor shares and investment prices worldwide, whereas the capital price remains stable. For instance, the labor share reduced from 64% to 58% in 1950-2010 (Bureau of Labor

Statistics). Likewise, using Penn World Table (PWT) 9.0, the world's average labor share fell from 62% to 58% in 1992-2010. Previous work had documented that the world average corporate labor share weakened from 61% to 55%.

Using the fixed asset accounts from the Bureau of Economic Analysis, they document that the U.S. capital price did not decline from 1953 to 2010, in contrast to previous literature, whereas the investment price declined 50%. The average world price of capital and investment follow a behavior similar to the US, but with a lower magnitude. For instance, the investment price dropped 15% in 1975-2010, whereas the price of capital diminished by 3% (PWT 9.0). Karabarbounis and Neiman had found similar declines in the price of investment, which are more pronounced, using the World Development Indicators database. The authors find disaggregated series of ICT and non-ICT investment based on classical literature by Christensen, Hall and Jorgenson and data from the World Information Technology and Services Alliance, the International Telecommunication Union, the Bureau of Economic Analysis and PWT 9.0. Their series imply that investment in information and communication technology (ICT) has a falling price and a rising investment share. The share of ICT investment climbed from almost zero to 8% from 1980 to 2010, whereas the ICT share on capital stock increased from 1.5% to 3%.

A competitive firm that uses a constant-returns-to-scale production function with multiple capital inputs and labor can have an aggregate unit labor-capital elasticity of substitution compatible with many disaggregated substitution or complementarity combinations. For example, computers and labor may be substitutes, but structures and labor may be complements. The aggregate labor-capital elasticity of substitution is equal to the percentage change in the labor-capital ratio from a small uniform change in the relative capital price in all capital inputs, where the relative prices between capital types are held constant. Equivalently, the aggregate elasticity can be written as an average of own and cross elasticities for each capital type weighted by disaggregated capital expenditure shares. It directly implies that if capital expenditure is concentrated in one factor, then this factor's elasticity dominates. If all the capital expenditure were in computers, then the computer elasticity would be equal to the aggregate elasticity. Given the weighted average composition of the elasticity of substitution, different disaggregated substitution and complementarity combinations of capital types and labor may lead to the same aggregate elasticity of substitution.

The authors change the Karabarbounis-Neiman regression to estimate disaggregated elasticities. Using annual country data, they regress the trend percentage change of labor shares on ICT and non-ICT investment price, where the left hand-side variable is adjusted by the labor-capital expenditure ratio. The elasticity of substitution is a simple affine transformation of the coefficient of this regression. The authors point out that the Karabarbounis-Neiman elasticity of substitution estimator is biased given it does not take into account disaggregation, in particular, different trends of ICT and non-ICT investment.

Eden and Gaggl calibrate the production function parameters using the standard neoclassical growth model. In equilibrium, marginal products equate factor prices. This set of first-order conditions maps relative prices to capital-labor ratios, which depend on elasticities of substitution and input shares. They target four parameters that govern the substitutability and shares of labor, ICT and non-ICT capital. Elasticities are common across countries, whereas patterns of specialization/shares of ITC and non-ITC capital are country specific. They assume a unit labor-capital elasticity of substitution in the US at the initial steady state. They matched the Karabarbounis-Neiman regression coefficient, the ICT investment share and the labor shares in each country at the steady state. They infer depreciation rates from investment and capital series. In preliminary results, they found that the world average elasticity of substitution between labor and ICT capital is 1.37, whereas between labor and non-ICT capital is 0.67. The matched world-average aggregate elasticity of substitution is 1.04 in the first year, and 1.08 in the last year.

They conclude that labor is the main limiting factor for growth. If reproducible factors prices decrease, then welfare gains depend on substitutability with labor. More substitutable factors will be more "labor saving." More broadly, they found that the elasticity of substitution and aggregate price decline do not estimate the impact of technology on the labor share. For instance, if the price of the capital that is more substitutable with labor declines, then the effect on the labor share will be more substantial, and even higher if its capital expenditure share is higher.

The audience wondered if they can extend the analysis to different types of labor. A member of the audience also queried how to calculate ICT prices. They mentioned that the results might be sensitive to how the ICT capital's price is calculated. They also questioned why the authors chose 1992 to be the initial steady-state year and whether prices before 1992 were constant. They wondered if it is adequate to extrapolate the U.S. ICT shares and elasticities to the rest of the world and if it is a good counterfactual.

New Evidence on Cyclical Variation in Labor Costs

Grace Weishi Gu and Eswar Prasad

The authors analyze the cyclical behavior of both wages and non-wage labor costs over the business cycle using job/positions for nearly 6600 establishments per year. They use the annual National Compensation Survey conducted by the Bureau of Labor Statistics (BLS) for 1982-2014. This survey includes detailed information on several categories of firms' labor costs, including disaggregation of firm-paid employee benefit expenditures. They argue that this dataset provides a better understanding of the cyclical behavior of firms' labor costs, in contrast to the previous literature, which provides only a partial picture of the cyclicality of worker compensation. Using this dataset, they document that the share of benefits in total compensation increase from 27% to 31% in 1982-2014, with health insurance accounting for a vast increase. Their main shortcoming is that the dataset does not have information about specific workers, inducing a so-called job switcher bias, even though it has a considerable amount of information about the characteristics of the sampled establishments and their jobs.

In a first contribution, they provide a detailed empirical characterization of cyclical variations in total labor cost and its components. Their main result is that real wages, benefit expenditures, and overall labor costs are all countercyclical. Their results are robust to different indicators of the business cycle (based on either GDP, employment or the unemployment rate) and different methods to deflate the total labor costs (either the PPI or the CPI). Real benefit expenditures appear less countercyclical than real wages or total earnings, which varies across establishment-job characteristics. They also find that wages and benefit expenditures are the most countercyclical for skilled occupations with a higher compensation. Both wages and overall labor costs are more countercyclical in the service sector compared to the manufacturing sector. For the fishing and forestry sector, wages and total labor costs are pro-cyclical.

In a second contribution, they provide partial explanations for why their findings differ from previous literature, which most have found pro-cyclicality in wages and earnings using data at the individual level. They observe none individual worker characteristics since the BLS survey is at the establishment and job levels. For instance, their analysis lacks the differential patterns of entry and exit of workers by skill level or experience common in the business cycle which the literature based on individual-level surveys includes.

The authors make three points about the differences between their findings and previous literature. First, they find that composition effects derived from jobs, firms or sectors effects play a little of a role in explaining their counter-cyclicality results. Second, by distinguishing straight-time wage rates from earnings, they find that earnings were pro-cyclical during 1982-2007 as previous work concluded, while wages were cyclical. Third, they mention that workers' switching behavior might explain these differences. Similarly, Gu and Prasar do not use the quarterly data of the NCS because it starts in 2004, whereas individual and household surveys have a higher frequency for more years.

They claim that there is an increasing counter-cyclicality of real labor costs since the 2007 financial crisis. The authors report that benefit expenditures appeared to be less rigid than wages. Nominal rigidities in both components of labor costs have risen over time and appear to strengthen in recession. Their cyclicality results seem to depend on inflation or, as they call them, aggregate demand shocks. In particular, they mention that the pro-cyclical behavior of inflation has increased.

The audience criticized the use of GDP or unemployment without extracting the cycle from the series (e.g., filtering or using other techniques) or comparing including a dummy for NBER recessions. They also noted that the results regarding increasing counter-cyclicality after 2007 might suffer small sample bias. Even more noteworthy, the participants commented that there are a few recessions in the sample period. They asked why the authors include a time trend in first difference regressions. They asked whether they could aggregate the data at the sector level to check if their results hold for more aggregate data and to compare them to previous literature. The result of bonuses' counter-cyclicality also seemed odd to the audience.

Taxation, Expenditures and the Irish Miracle

Paul Klein and **Gustavo Ventura**

The authors investigate the extraordinary growth in output per adult in Ireland observed between 1980 and 2005. They concentrate on the impact of declining corporate tax rates and reductions in government consumption suggesting these fiscal measures played a significant, but secondary role in the "Irish Miracle." Relatively small increases in Total Factor Productivity (TFP) account for most of the growth, but their results suggest complementarities between these fiscal and other driving forces. The authors also highlight the importance of openness to foreign capital inflows.

The model depends on two sectors of production, manufacturing and services, in a small-open economy with imperfect capital inflows. A government sector allows for changes in fiscal policy–distorting taxes and government consumption and transfers. Production in each sector depends on labor and tangible and intangible capital. Foreign capital inflows are limited by a collateral constraint. The authors infer TFP sequences to match the observed rise in GDP and test the contribution of tax reform, government spending, and TFP to output growth.

Non-manufacturing business income taxes were reduced from 50% in 1980 to 12.5% in 2003. Government consumption fell from 20% in 1980 to 14% in 2005. The authors' results suggest that only 25% of the increase in output can be attributed to these fiscal changes. A relatively small (22%) increase in TFP during the time period is responsible for 62% of the increase in output. Only 87% of the total increase in output can be explained by either fiscal policy or TFP changes in isolation. This suggests complementarities and interactions between fiscal and other driving forces. The ratio of GNP to GDP shrank from 97% in 1980 to 86% in 2005. Restricting Ireland's economy to being closed to foreign capital movements during this time period suggests that output would have increased by less than half of what they observed highlighting the importance of openness in the Irish Miracle.

During the presentation, some participants were curious of the comparison of Ireland's remarkable growth to the growth experienced in the United States or Western Europe during the time. Were the countries similar enough to say Ireland's growth was a miracle? But, many of these other countries were also experiencing reductions in corporate tax rates and some TFP increases as Ireland during this period suggesting Ireland's growth was exceptional. The authors pointed out that understanding what is driving changes in TFP presents an important goal for future research. Participants were also curious and suggested several mechanisms including Ireland enjoying becoming a member of the European Union in 1973, changes in female employment over time, and increased human capital arising from introducing free secondary school in 1967. There was interest among participants about the choice to focus on 1980-2005, and some were curious if the results were robust to changing the time period. There was a discussion on whether there was any increase in the labor tax rate in response to decreases in the corporate tax rate to help balance Ireland's budget. Or whether there were any lump-sum transfers associated with the reduction in business income taxes during this period.

Tax Progressivity, Performance Pay, and Search Frictions

Arpad Abraham, Pawel Doligalski, and Susanne Forstner

There is a large body of literature on the classic trade-off of progressivity taxation: it provides insurance but distorts incentives. In one strand of the literature, they examine this notion in frameworks where wages or labor productivities are exogenous. The distortion is typically coming from the intensive margin of labor supply. The authors try to partially endogenize the wage shocks and examine how such modification changes the implication of the theory.

Specifically, wage shocks are because of search and moral hazard frictions. Job-to-job flows and transition through unemployment create an external wage ladder, while performance pay for moral hazard frictions creates an internal wage ladder. In this environment, workers face job offer risk both between jobs and out of unemployment: when a worker meets a firm, they draw a match productivity. Because this is pure luck from the workers' point of view, tax progressivity improves welfare by redistributing wages from the lucky to the unlucky. However, workers also face incentive risk within job spell for moral hazard. Tax progressivity makes incentive provision more expensive, which may hurt welfare in some cases.

The authors investigate the effect of tax progressivity on welfare quantitatively through the model. They find distributional effect of tax progressivity on firm profit, unemployed workers' benefit, and net wage payment. Overall, welfare is reduced when progressivity increases while firms' profits increases. They show that progressivity taxation has a direct effect on welfare as it reduces dispersion of net wages which increases welfare. Because firms adjust their long-term contracts and bargaining thresholds, it indirectly decreases welfare. They conclude that evaluating tax progressivity reforms may be misleading if the response of new employer offers is not taken into account.

One audience member asked if they correlate the offers, how would the results change. The author noted that even though the wage offers are not exogenously correlated, they are endogenously correlated in their model framework. Another audience member asked whether taxation affect the incentive constraint of the contract problem. The author replied that it does so endogenously by affecting the amount of incentive payment that the firms offer. One audience member asked whether the implication would change if wage differences were derived from permanent components such as workers' ability instead of transitory factors such as luck. The author acknowledged that the current version of the paper cannot answer that question, but noted that they could add worker abilities to the model.

The Effects of Marriage-Related Taxes and Social Security Benefits

Margherita Borella, Mariacristina De Nardi, and **Fang Yang**

Yang looks at how marriage related policies affect the labor supply of both women and men, and, savings decisions. In the United States taxes and old age Social Security benefits depend on marital status. Yang notes that the labor supply of married women has been changing over time and asks do marriage-related tax policies have differing effects for different cohorts. Yang uses a life-cycle model of couples and singles using the Method of Simulated Moments to estimate the effects of eliminating this marriage related provisions on labor supply and savings on the 1945 and 1955 birth cohorts. The results show that marriage related provisions reduce the labor participation of married women over the entire life cycle, the participation of married men after the age of 55, and the saving of couples. Even though the 1955 cohort has a much higher labor market participation of married women, both the 1945 and 1955 cohorts see large effects.

Yang develops a life-cycle model with single and married people in which single people meet partners and married people have a chance of divorce. The working age population faces wage shocks, and the retired age population faces medical expenses and an exogenous probability of death. Individuals in couples face the risks of both partners. The number and ages of children depend on maternal age and marital status. There are both time costs and monetary costs of raising children. Households self insure by saving and by choosing whether to work and how many hours to work. Wages are determined by accumulated human capital on the job. A conference participant questioned how missing they handled wages for those who do not work, who are mostly women. They impute missing wages using observationally similar individuals with non-missing wages.

They estimate the model using the Method of Simulated Moments and data from the Panel Study of Income Dynamics and from the Health and Retirement Study for the cohort born in 1941-1945. For the 1945 cohort, the current structure of joint income taxation and Social Security benefits provides strong disincentives to work for married women, single women who expect to marry, and married men older than 55. Using the estimated preference parameters from the 1945 cohort, they estimate the model for the 1951-1955 cohort which had a much higher participation of married women and for which policy may have very different effects. The model shows similar effects on the 1955 cohort for participation, wages, earnings, and savings. The estimated model matches the life cycle profiles of labor market participation, hours worked, and savings for married and single people for both cohorts.

This paper is the first estimated structural model of couples and singles that includes participation and hours decisions for both men and women in a framework with savings. The results suggest that this marriage related polices significantly reduces the savings of couples and the labor force participation of women. The model shows that eliminating the current marriage related rules increases participation at age 25 by over 20 percentage points for married women and by five percentage points for a single woman. This marriage based rules also decrease savings of married couples by $40,000 at age 70 and wages for married women by about 10% because of the effect of experience on wages.

Inequality, Redistribution, and Optimal Trade

Roozbeh Hosseini and Ali Shourideh

Hosseini looks at the relationship between optimal trade policy and redistributive policies. Evidence suggests that international trade and global reallocation of production has led to significant changes in the allocation of labor and inequality of income in the United States. The authors study how income taxes and trade policy can be designed to balance the efficiency gains from trade and the costs resulting from the increased inequality from trade. The results show that when personal income taxes can depend on workers sectoral choices, then free trade is optimal. However, when personal income taxes are only determined by income, then production must be distorted. The authors determine two general properties of these distortions. First, they are independent of the structure of trade networks and trade elasticities. Second, they must take the form of value-added taxes. Using a multi-country Ricardian model of trade, the authors show that sector-specific transfers must be large and without taxes distortions to trade are significant.

Hosseini develops a model of trade where global production occurs through input-output connections and workers have no mobility. The authors study the joint decision of optimal trade policy and income taxes under the assumption of cooperation among countries. In the model, production is done competitively across countries and goods that are produced in one country can be used for production in another country. Two types of personal income tax are considered, allowing taxes to depend on a workers' sectoral choice and their income and allowing taxes to depend only on workers' income. With sector-specific income taxes, it is never optimal to distort trade. Without sector-specific income taxes, distortions to trade are optimal. The authors show that the main tool for redistribution is differential taxes on producers. The authors also show that the optimal producer taxes are in the form of a Value-Added Tax (VAT) where firms may deduct the cost of intermediate input from their tax bill.

Using a quantitative model, the authors answer the question how should a trade agreement involving the United States and China be designed and what should be the VATs. In the model there are two layers of production, final and intermediate goods. Intermediate goods use labor to produce and are tradable. Final goods are produced with intermediate goods and are non tradable. The China shock is modeled as an increase in total-factor productivity (TFP) in China. With the China shock, industry level taxes are optimal. One discussant asked what the optimal tax on the producers is determined by. The author responded that they depend on specialization of the labor force.

Hosseini develops a framework to analyze optimal taxation policy when trade has winners and losers. Optimal value added taxes on producers are determined at the industry level. The authors show that when income taxes are sector-specific, free trade is optimal. Without sector-specific income taxes, trade is distorted using value-added taxes and subsidies. Using the China TFP shock, the authors show that the distortions from trade are large and that sector-specific value-added taxes cause large gains in aggregate welfare.

Taxation and Organization of Knowledge

Marek Kapicka and Ctirad Slavik

Though the upper tail wage inequality has increased, while the lower tail wage inequality has decreased after 1986 in many developed countries, standard models which assume exogenous distributions of wages or abilities cannot fully explain the observed changes in the upper and lower wage inequality. Also, the interaction between changes in wage inequality and changes in taxes is nonexistent or limited. This paper studies the interaction between taxation and wage inequality and analyzes optimal tax progressivity by using a theory of knowledge-based hierarchies.

In the model of knowledge-based hierarchies, it takes time to coordinate and communicate knowledge among managers and production workers. When the required communication time decreases, good managers become relatively more useful in solving tasks, which results in higher wages of good managers. As a result, upper tail inequality increases. It gives managers additional time to supervise more production workers. Thus, even the production workers at the bottom of the ability distribution earn more from being matched with better managers, which reduces lower tail wage inequality. Distortive taxation

also affects similar to changes in the required communication time by changing equilibrium hours worked. In the equilibrium, agents become managers, production workers or self-employed. The top wage inequality decreases if the ratio of hours worked and time cost decreases. Also, as the threshold ability to be a manager increases, there will be fewer managers, and then the top wage inequality will increase. The bottom wage inequality increases if the ratio of hours worked and time cost decreases. If the threshold ability for being a production worker increases, the bottom wage inequality also increases.

In the benchmark, agents at both ends of the ability distribution benefit a lot. Low ability agents gain from being matched with a manager that solves some of their problems. High ability agents gain from being able to supervise a relatively large number of production workers. Given the estimated progressivity of the current U.S. tax system as 0.161, it gives higher welfare to increase the tax progressivity to 0.408 if the wage distribution is exogenous and does not interact with changes in the tax system. However, if the distribution of wages is endogenous, the optimal value of tax progressivity is 0.041. The reason that optimal progressivity is so low is that wages adjust to changes in tax progressivity. A decrease in tax progressivity increase hours worked, which gives managers more time to supervise production workers. As a result, the log of the 50/10 ratio, the lower tail wage inequality decreases from 1.069 to 0.988 at optimum.

An audience member asked whether time needed to solve tasks is independent of the difficulty of tasks. Some of them also asked whether threshold abilities to be a manager and a production worker change with measures defined for the top and bottom wage inequality in this paper. One was concerned if communication time is considerable, everyone can be self-employed. Another audience member asked whether matching function between managers and production workers is endogenous. Finally, several audience members asked why the model economy is so sensitive to the change in tax progressivity.

Prices and Inflation when Government Bonds are Net Wealth

Marcus Hagedorn

The prevailing view on prices and inflation and the conduct of monetary policy is that monetary policy works through setting nominal interest rates, that monetary policy controls the inflation rate and that prices are determinate if policy responds sufficiently strongly to inflation, known as the Taylor principle. Fiscal Policy is largely irrelevant in this view. The author proposes that the modification of existing models such that government bonds are net wealth (the value exceeds the value of tax liabilities) and government bonds are nominal offers a new and different perspective on these topics. While monetary policy operates as in the prevailing view and controls the nominal interest rate, fiscal policy is now assigned a significant role.

The author documents two results. First, in contrast to the conventional view, the long-run inflation rate is equal to the growth rate of nominal fiscal variables, which are controlled by fiscal policy. This holds even when monetary policy operates an interest rate rule with a different inflation target. In the short-run, prices and inflation are jointly and uniquely determined by fiscal and monetary policy. In contrast to conventional wisdom, a tough, independent central bank not only does not guarantee price stability in the long-run but also has no direct control over long-run inflation even if it follows an interest rate rule which satisfies the Taylor principle. By controlling the nominal anchor, the fiscal policy always wins out in long-run inflation. What a central bank independence ensures is that the treasury cannot impose fiscal policies on the central bank.

Second, the price level is globally determinate when monetary policy works through setting an arbitrary sequence of nominal interest rates, for example through an interest rate peg or an interest rate rule. Fiscal policy sets sequences of nominal government spending, taxes, and government debt, for example through a fiscal rule, and these sequences satisfy the present value government budget constraint at all times and for all prices. In this environment, the author shows that the steady-state price level is determinate even if nominal interest rates are constant and derives conditions on policy rules to ensure global determinacy.

To understand these results, the author first assumes no economic growth. When government bonds are net worth, shifts in the stock of real public debt affect real aggregate demand. When in addition government bonds are nominal, shifts in the price level shift the real value of debt and thus affect real aggregate demand. It then determines the price level such that aggregate demand equals aggregate supply. Also, there is not a unique steady-state real interest rate determined by households' discount factor but it depends on the amount of real bonds

available. This means that depending on the amount of bonds available, a continuum of steady-state real interest rates is workable. Monetary and fiscal policy sets the steady-state nominal interest rate. Fiscal policy sets the growth rate of nominal government debt. In a steady state, the value of real government debt is constant, such that the steady-state conditions for fiscal policy is that the growth rate of nominal debt is equal to the inflation rate in the absence of economic growth. The real interest rate is then determined by the Fisher equation as the ratio of the nominal interest rate and the inflation rate. Price stickiness is largely irrelevant for steady-state and serves to rule out hyperinflations.

One audience member asked whether the monetary authority can hold bond initially. The author noted that in the model monetary authority and the government decide separately and the monetary authority does not hold bond. Another audience member asked whether the results hold if the government can default on the debt. The author replied that default would make the model more complicated, but it does not change the result. It only changes the amount of bonds issued. One audience member asked whether there is a unique path from one equilibrium to another. The author noted that since bond can respond smoothly, the transition path would also be smooth and unique.

Inflation, Debt, and Default

Sewon Hur, Illenin O. Kondo, and Fabrizio Perri

Dynamics of inflation over a business cycle has been dramatic in advanced economies during the past 50 years, inflation moves pro-cyclically and sometimes counter-cyclically with economic activities. Besides, the authors also observe that when inflation co-varies positively with domestic consumption growth, returns on domestic nominal debt are high (low) when consumption growth is low (high), and the more countercyclical inflation gets, the higher the interest rate. May the difference in the comovement of inflation with economic activity suggest a different effect on real sovereign yields, and further debt dynamics and debt crises? Or can cyclicality of inflation be one of the main drivers of the movement in the real interest rate?

First, the authors verify the observation empirically that cyclicality of inflation is associated with lower borrowing costs, especially when in good times. They find that the higher covariance of inflation with economic activity is robustly and significantly associated with lower real interest rates on government debt, a phenomenon the authors call inflation pro-cyclicality discount. They also find the magnitude of the discount to be larger when the economy is in good times than in bad times. Then they illustrate the mechanism of pro-cyclicality discount using a simple two-period model with inflation and default. During good times, the pro-cyclical inflation makes debt less risky for the lender, and so works as a good hedging option; while for the borrower, procyclicality increases the possibility of making higher repayment, and so results in a decrease in the demand for borrowing. Increase in the supply and a decrease in the demand will unequivocally reduce the equilibrium interest rate, though will leave the change in the equilibrium level of debt uncertain. With default risk being present, or when an economy is more likely to be in bad states, higher inflation procyclicality implies default to be more likely, altering the hedging option, and so may increase the cost of borrowing, leaving the effect of procyclicality less certain. The numerical example given in the paper shows inflation procyclicality can increase real interest rates when default risk is present. This resonate with the fact that, in bad states, counter-cyclicality, which implies low repayments, is a substitute with default, and procyclicality to be complement with default. Lastly by extending the standard sovereign default model with exogenous inflation shocks and domestic risk-averse lenders, along with rigorous calibration, they verify that processes of inflation, especially inflation cyclicality, can be essential in explaining interest rates and dynamics of default. The two extensions allow them to explicitly analyze the endogenous connection between stochastic discount factors of the domestic lenders, debt pricing, and default probabilities, and to analyze how this relation changes as the co-movement between inflation and consumption growth varies.

During the discussion of the research, it raised many comments. Following Boudoukh (1993), the authors use constant coefficient VAR when constructing an empirical relationship between the inflation and consumption growth, while one participant pointed out that the relationship between inflation and consumption growth is presumably time-varying, taking into consideration the regime changes in economies between good and bad times might be more plausible for identification. Another participant questioned if it can be the default risk itself that directly affects the

changes in real interest rate rather than the cyclicality of inflation, while as the presenter explained, though it may be the case in some developing countries, in the advanced economies the paper is addressing, the probability of default has shown not to be the main driver of the changes in real interest rate, and their research is showing that the comovement can instead be systematically connected to real interest rates. Someone made another comment on the necessity of the domestic lender assumption in their sovereign default model. As the presenter put it, the assumption is necessary in the sense it makes the lenders' endowment correlate more nicely with the domestic economic activities and to see the effect of comovement on the change in real interest rate, while it is not an innovative assumption for their model to work, as long as the lenders' endowment correlates with economic activities in some specific way, the relationship of cyclicality and real interest rate should be revealed. Their research suggests a new aspect to see the interaction of monetary policy and interest rates in the presence of sovereign credit risk, that can help understand the secular decline in real rates.

Macroeconomic Fluctuations with HANK and SAM: An Analytical Approach

Morten O. Ravn and **Vincent Sterk**

The authors incorporate incomplete markets and labor market frictions in the form of search frictions into a tractable New Keynesian model. The model has three types of frictions: Heterogenous agents (HA), New Keynesian nominal rigidities (NK), Search and Matching (SAM). The tractability derives from a limit on participation in the equity market and a borrowing limit in the bond market.

In the model, the agents face an endogenous idiosyncratic earnings risk because of search and matching frictions. This risk can be countercyclical or pro-cyclical. The interaction between HA and SAM is important for the implications of this risk. Countercyclical endogenous risk arises because of lack of unemployment insurance. When the economy is in recession, the jobs are harder to find if a worker loses her job. pro-cyclical endogenous risk arises because the wages fall in recessions which makes job loss less costly.

The countercyclical endogenous risk introduces an amplification mechanism crucial for the implications of the model. This mechanism arises for a demand-supply side interaction. In the recessions the job finding rate declines which means a high tightness of the labour market. This increases the idiosyncratic risk for employed households, hence their precautionary savings motive increases. On the demand side, higher savings reduces the demand for the goods and downward pressures the real interest rate which reduces the inflation. The drop in marginal costs reduces the real wages and increases hiring costs. Firms hire less and job finding rate drops further which induces a further drop in demand. This is the amplification mechanism resulting from the demand-supply side interaction. When the endogenous risk is pro-cyclical, the model has a stabilizing effect. The fall in job finding rate implies real wages to drop which makes job loss less costly, hence the demand for precautionary savings increases in recessions while it increases in booms.

In the model, three types of equilibria arise: intended steady state, liquidity trap and unemployment trap. The determinacy for intended steady state causes more stringent conditions under incomplete markets compared to complete markets standard New Keynesian models. As a result, the monetary policy needs to be more aggressive under incomplete markets to rule out expectational equilibria.

The model also explains the Zero Lower Bound (ZLB) endogenously. In standard New Keynesian models, it achieves ZLB via an exogenous shock to the discount factor. With this shock, households become more patient which reduces aggregate demand and hence the inflation rate and the real interest rate. Nominal interest rate declines by the interest rate rule and can hit the ZLB. Ravn and Sterk introduces micro-foundations for the discount rate shock. In representative-agent NK models, the more conventional negative productivity shocks do not reduce nominal interest rates because households have less income which reduces precautionary savings. This creates a puzzle about ZLB which is solved using exogenous discount factor shock in the literature. However, in the model with HANK and SAM, if the endogenous risk is countercyclical, a negative productivity shock reduces inflation and the nominal interest rate which may reach to the ZLB. The authors empirically show that the countercyclical endogenous risk is the more relevant case when they set the parameters to the values estimated in the literature.

Agency Costs, Supply Side Uncertainty and the Zero Lower Bound

Victor Dorofeenko, **Gabriel Lee**, Kevin D. Slayer, and Johannes Strobel

Lee shows that second-moment shocks from supply side uncertainty only generate enough impulse responses to lead interest rates to the zero lower bound (ZLB) if they are unexpected and sufficiently large. This approach differs from earlier literature which uses first moment shocks to households' discount rate or a combination of productivity and discount rate shocks to meet the ZLB. The authors find the existence of a lower bound makes the adverse effects of uncertainty on real variables worse. They also find that financial variables such as the risk premium and bankruptcy rate respond less strongly at the ZLB.

The authors use endogenous agency costs and time-varying second moment of productivity in a standard New Keynesian model. Each firm's output depends on both aggregate and idiosyncratic technology. After aggregate shocks have realized, but, before observing their idiosyncratic technology, firms decide on how many inputs they hire to maximize expected profit via external funds. If a firm is not productive enough to repay its loan, it declares a default, and the external lender takes all output after paying a monitoring cost proportional to the total production costs.

The authors solve their model using first-order perturbation piecewise linearly. Although the policy function is linear, the influence of second moments on equilibrium does not disappear since the vector of state variables includes the variance of an idiosyncratic technology. They also use first, second, and third order pruning to solve the model. They find that one standard deviation of a shock does not lead the economy to the ZLB. Given their calibration and steady state value of risk of 0.207 and a nominal annual interest rate of 5.75%, the smallest size of the unexpected shock to risk required to lead to the ZLB is 30%. That is why the authors use three standard deviations of innovation when they compute the impulse response function.

Regarding the impulse response functions, the impact of a productivity shock on output and investment shows similar patterns with the financial variables qualitatively and quantitatively. In response to a 3% unexpected increase in the discount rate, the interest rate would fall to -2%. If there is a ZLB, both output and inflation drop more than without the ZLB. An unexpected risk of 36% also makes the interest rate fall to -2%. Because of existence of the ZLB, the real return on investing in the risk-free asset is higher, and investment in the risky asset falls even more.

Some audience members asked why the authors take away macro uncertainty and risk premium separately though they are highly correlated. One was curious about whether the economy has a onetime shock or continuous shock. Another members asked why shocks matter if the authors have mean-preserving dispersion in their model. It concerned several members why there is amplification in response to small shocks in the financial market. One member asked whether all parameters push the economy to the ZLB. Finally, there were audience members to ask why aggregate consumption increases in response to adverse shocks.

Excess Capacity and Liquid Accounts as a Store of Value

Alessandro Mennuni

Motivated by the observed amounts of savings held in liquid forms when several means of payment do not require holding liquid funds, Dr. Mennuni asks why do we need so much liquidity and restudies the role of money in an economy. While existing theories highlight money demand for transactions, the author argues this cause alone may not explain all the liquidity holdings we observe in modern societies, especially considering the vast availability of credit that crowds out transaction money demand.

This paper introduces a macro-economic framework where money emerges endogenously as a store of value because of a search friction between buyers and sellers in the goods market. Its innovative micro-foundation links the observed amounts of liquidity holdings with the credit market. Money and credit are substitutes as stores of value, and non-substitutes as mediums of exchange. This inference makes money as a candidate to explain the large amounts of liquidity despite credit. If we associate supply and demand with the value of money, then search friction is also a natural source of the business cycle.

His theory explains money demand when anonymity and the lack of enforceability that limits insurance and credit are relaxed. The author suggests the connection between money demand, aggregate demand

and equilibrium excess supply explains the joint behavior of monetary aggregates and real economic activity. In particular, the model shows evidence of recessions consistent with the surge in liquidity holdings and a drop in production capacity utilization, as documented for several recessions including the Great Recession.

During the presentation, one audience member raised the question of using GDP to measure the total number of transactions in the U.S. economy, Dr. Mennuni acknowledged the potential inaccuracy and responded that even assuming the maximum amount of credits, the necessity of the existence of money is justified.

The Changing Roles of Family Income and Academic Ability

Lutz Hendricks, Chris Herrington, and **Todd Schoellman**

One fundamental goal of U.S. higher education is to make college broadly accessible to the general public. By integrating the results of 42 different datasets and studies and constructing a time series of college attendance patterns, the authors documented large changes in such patterns in the United States during the 20th century.

Updegraff (1936) suggests family background played the dominant role in determining who attended college, while academic ability played a small role. However, this trend reversed later after World War II. By the 1960 cohort, academic ability was the main driving force for college attendance, with little change between 1960 and 1979. Federal government loan and grant programs, along with the surge in federal spending associated with the GI Bill were two common reasons accounting for this shift in the trend of college attendance. However, analyzing data from 1919 to 1979, this paper's empirical results suggest that federal loan and grant programs occurred too late to generate the reversal.

The presenter explored two plausible alternative driving forces that might generate the reversal in sorting patterns: changes in the pool of high school graduates and changes in the college application cost. He concluded that variation in high school graduates and falling application costs do not have a significant effect in generating the reversal in sorting patterns.

The main finding of this paper is that prior to WWII, family income or socioeconomic status was a better predictor of who attended college, whereas academic ability was more important afterward. On one hand, quality at better colleges rises, thus attracting high-ability students. Falling quality at the remaining colleges dissuades low-ability students, therefore generating the reversal.

Overall, the talk was well received. Audience members raise several questions concerning the datasets used in the paper. The presenter acknowledged that while he and other coauthors had harmonized the results from several historical studies; they considered only two cohorts (1933 and 1979) in the static model used in the paper. Dr. Schoellman noted that they are working on improving their explanations accounting for the difference in college attendance patterns between data and model, mainly for the group of people in the top quartile of the high parental income distribution but the bottom quartile of the ability distribution.

Aging and the Macroeconomy

Juan Carlos Conesa, Daniela Costa, Parisa Kamali, Timothy J. Kehoe, Vegard M. Nygaard, Gajendran Raveendranathan, and Askhas Saxena

Aging population challenges the world economy, it is a defining issue of our time. The concerns on an aging population stem from decreasing labor supply, and hence the possible lower income, and from increasing demand for social security, which potentially means higher government spending. The paper, pivoting on an aging population in the US, explores if an increase in labor productivity because of a larger proportion of college graduate may partially mitigate the fiscal burden caused by the aging of the population.

The authors point out that the old-age dependency ratio in the US is projected to increase from 25 to 50 percent by 2100 due to the aging of the population and the share of Americans with a college degree is projected to increase from 32 to 67 percent. As college-educated individuals have relatively higher labor productivity than the non-college graduates, the large increase in college attainment is likely to partially mitigate the fiscal burden caused by the aging

of the population. To study further the macroeconomic implications of aging, i.e. its effect on output, factor inputs, medical expenditures and government spending, in an environment that features both increasing survival probabilities and an increasing share of college graduates, the authors develop a general equilibrium overlapping generations model with incomplete markets and heterogeneous consumers, where the key is to have different endogenous insurances, demand for which is to be determined by consumers' types, heterogenous shocks and government's schemes on social welfare. They then calibrate the model along a transition path from 1950 to 2100 that features rising survival probabilities, an increasing share of college graduates, and rising healthcare costs.

They find that increased college attainment has a quantitatively large effect on output, medical expenditures, and government spending. The results show that the increase in the share of college graduates compensates for all the increase in public healthcare expenses and most of the increase in Social Security spending. This follows even though college-educated individuals spend more on healthcare, live longer, and claim more generous Social Security benefits than non-college-educated individuals. As a result, they find that payroll taxes will only have to increase by 3 percentage points between 2015 and 2100 to balance the budget period-by-period even if the current eligibility criteria and benefit levels for social insurance programs are preserved. These results contradict the conventional prediction it will be too costly to maintain the social insurance programs because the increase in taxes required to finance them will have detrimental implications for saving and labor supply.

During the discussion, several comments were raised. First, when comes to construct the eligibility for social security, the authors consider individuals' entire history of earnings, while using summary statistics of lifetime income or only the last working period's wage for determining the eligibility may make the problem more tractable; second, as one participant pointed out, and the presenter clarified, higher education affect the projection results not only because of higher income it induces but also because of the change it makes to the composition of health distribution in the population, which is indeed captured by the model, and the effect of education on health composition is critical to the results; third, there were concerns about their model being not able to capture the trend of expanding beneficiary groups of social security, and so the projection to be imprecise, to get further insightful policy implications, extensions on the model were anticipated.

Corporate Tax Cuts and the Decline of the Labor Share

Baris Kaymak and **Immo Schott**

There has been striking evidence that the labor income share has been declining across the world. In this paper, the authors show that the declining labor share and corporate tax rates strongly move together. Globally, the labor share has fallen from 63.6% to 56.1% between 1981 and 2006. During the same period, the corporate tax rate has decreased by 17 percentage points on average. We have also observed this global trend in the US. The labor share falls by 13.5 percentage points between 1953 and 2014, while the corporate tax rate has decreased from 50% to 27% between 1950 and 2003.

The authors use a general equilibrium model of firm dynamics to study how declining corporate tax rates affect labor income share in the US. They change a version of firm entry and exit model by including heterogeneity in productivity and capital intensity. First, equilibrium results show that the cost elasticity of output depends on the capital share parameters. Thus, capital-intensive firms react more sensitively when the cost of capital changes. Second, the price level affects an economy through the real wage rate only. Third, as the capital share increases, taxable income monotonically increases. As a result, a drop in the cost of capital induced by lower corporate tax rate increases output, especially by capital-intensive firms. Higher output decreases the price level and raises the equilibrium real wage, which shrinks labor-intensive firms further and results in the industry's concentration among capital-intensive firms.

For policy experiment to decrease the corporate tax rate from 52% to 18% between 1967 and 2007, the authors calibrate the model to an economy of 1967. Their model matches the data well in two critical aspects. First, the distribution of labor shares is not skewed significantly towards either high- or low-labor share firms. Second, the distribution of value added is slightly skewed towards firms with low labor shares. When the authors decrease the corporate tax rate in the policy experiment, the labor share decreases from 55.6% to 48.5%. They can decompose the total decline in the labor share into direct and indirect effects. The direct effect comes from

the decrease in the corporate tax rate, which lowers the cost of capital. The indirect effect comes from the change of the equilibrium price level accompanied by the tax cut. Aggregate output increases by 30.5% and the value added weighted median labor share falls from 52.04% to 38.31%.

Several audience members asked how the authors compute the labor share, pointing out the labor share in Ireland is too low compared to other literature. One concerned was about how the authors could separate each country's contribution to the decline of the labor share in a specific country in the world of international trade. Some members suspected how labor share could be greater than 1 and whether the concentration of firms with low capital intensity is by construction. Another audience member was curious whether there is a final tax which a firm to exit the market has to pay when it sells capital. Finally, there were audience members to ask whether the authors looked at the transition between two periods besides compare just two steady states.

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