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conference held in February 2017.

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FROM THE LAB

UC SANTA BARBARA | Laboratory of Aggregate Economics and Finance

Bubbles

Presentation Summaries

Note: speakers are highlighted in author listings.

Fourth Annual Macroeconomics and Business CYCLE

Presentation Summaries

Note: speakers are highlighted in author listings.

Associate Director's Message
Peter Rupert

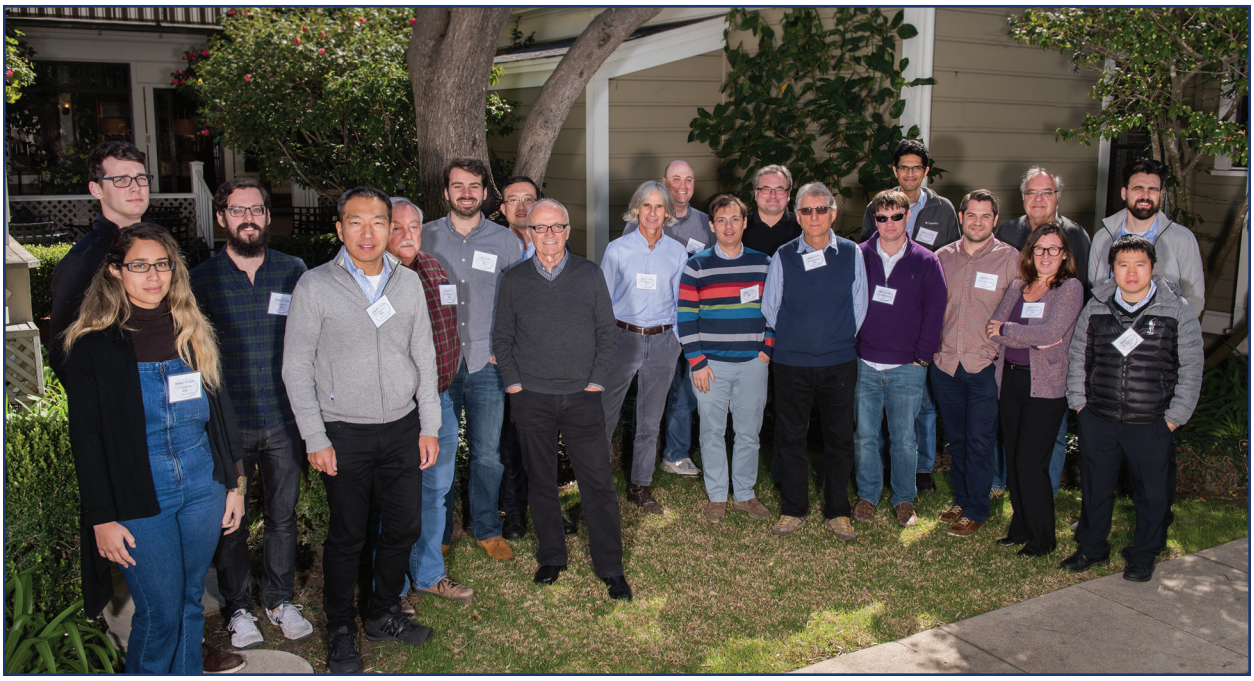
This volume of From the Lab contains two conferences sponsored by the Laboratory for Aggregate Economics and Finance. On February 24-25, 2017 UCSB hosted a conference on, and called, "Bubbles". The conference was organized by Zachary Bethune, Assistant Professor of Economics, Ana Fostel, Associate Professor of Economics, and Eric Young, Professor of Economics, all from the University of Virginia. Many popular accounts of the economy often assign an important role to bubbles (housing prices, stock market, etc.), but the exact meaning of this term is unclear; it seems to mean simply a large increase in, for example, an asset price. In contrast, in the academic literature a bubble is a deviation from the fundamental equilibrium, but that leaves open the issue of what the right fundamentals are -- that uncertainty means it is difficult to spot a bubble in the data. The eleven papers at the conference explored this notion in many areas.

I have to admit, these UVAens certainly get the award for choosing names for the conferences. For example, Eric and Zach organized "Pecuniary Externalities - The Back of the Invisible Hand" in 2016. And, have an upcoming one October 2017, titled "Why the Government Does Whatever It Is That the Government Does."

The Fourth Annual Macroeconomics and Business CYCLE Conference was held May 8-11 at the Upham Hotel in Santa Barbara. The idea of these conferences is to bring together a wide range of topics over the course of four days. While the typical LAEF conference is quite narrowly focused, this conference explores new research that would lead to much more focused future conferences. There were sixteen papers over the course of the conference. Having the papers in the morning makes it possible for extended interactions, with lots of ups and downs, amongst the participants in the afternoon.

Bubbles Conference Participants
February 2017

Gadi Barlevy - Federal Reserve Bank of Chicago
Zachary Bethune – University of Virginia
George Evans – University of Oregon
Ana Fostel – University of Virginia
Stefano Giglio – University of Chicago, NBER
Tomohiro Hirano – University of Tokyo
Rishabh Kirpalani – New York University
Finn Kydland – University of California, Santa Barbara
Kevin Lansing – Federal Reserve Bank of San Francisco
Thomas Lubik – Federal Reserve Bank of Richmond
Jun Ma – University of Alabama
Jianjun Miao – Boston University
Toan Phan – University of North Carolina Chapel Hill
Giacomo Rondina – University of Colorado
Peter Rupert – University of California, Santa Barbara
Pengfei Wang – Hong Kong University of Science and Technology
Eric Young – University of Virginia



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

Indeterminacy and Imperfect Information

Thomas Lubik, Christian Matthes and Elmar Mertens

The authors study equilibrium determination in an environment where multiple agents have different information sets. They show how indeterminacy can arise in environments with limited and asymmetric information, even though the full information version of the same model has a unique equilibrium. Additional structure is imposed on the characteristics of the multiple equilibria due to the limited information. Uniqueness of the equilibrium depends on the entire model, especially the information set used by the limited information agent.

The model environment consists of a fully informed agent and an agent with a limited information set that is nested within the full information set. All agents form expectations rationally, but the limited information agent utilizes a Kalman filter to make inferences about variables outside their information set. Gaussian innovations are assumed throughout to ensure that filtering is tractable. In the model presented, the authors assume that the central bank's information set is a subset of the full information set of the private sector. The central bank can set the nominal interest rate only as a function of their limited information set. Three information sets are considered: a noisy measurement of the real interest rate, a noisy measurement of inflation, and a noisy measurement of inflation with lagged revelation of state variables.

When the central bank observes real interest rate with measurement error, the limited information rational expectations equilibrium is indeterminate — even though the full information counterpart has a determinate equilibrium. Filtering introduces a stable root into the system, which leaves the forecast error unrestricted. Equilibrium conditions impose restrictions on the set of multiple equilibria, but belief shocks (sunspots) are unrestricted. When the central bank observes inflation rate with measurement error, the endogenous information set allows for feedback between prediction equations and private sector equations. For some parameter configurations, other equilibria besides the full information equilibrium exist. There is one non-linear restriction on three weights in the forecast error. Keeping the noisy measurement of inflation — and adding lagged endogenous and exogenous - outcomes to the central bank's information set — moves the information set further towards full information. In the simplified example presented this information structure makes the benchmark equilibrium unique, however this is generally not true.

The authors find that with limited and asymmetric information, there is more room for multiple equilibria to exist. The information structure, particularly the nature of the less-informed agent's filtering problem, impose restrictions on the nature of what these equilibria can look like. The structure of these multiple equilibria also crucially depend on whether the less informed agent has access to noisy estimates of endogenous and exogenous variables. ◊

Bubbly Financial Globalization

Giacomo Rondina

Rondina studies whether the recent surge in financial globalization made the world economy more susceptible to widespread incidents of asset price bubbles. Specifically, a theoretical mechanism that can predict major bubble-like fluctuations in asset prices in advanced economies from increases in financial markets integration since the mid-1990's is proposed. In autarky, the financially developed North produces enough assets to prevent bubbles from being viable. In the financially undeveloped South, the limited leverage potential of productive entrepreneurs makes the required returns on the bubble unsustainable even though bubbles can potentially offset the shortage of financial assets. When financial globalization occurs, bubbles become possible if the financial development of the South is increased and the globalized financial markets display a shortage of assets. The author argues that both conditions seem to have emerged over the last twenty years.

The model consists of the neoclassical growth model with overlapping generations. There are three generations: young, adult, and old. Consumption is only valued when old, output technology is constant return to scale, and capital and labor are paid at marginal returns. Both young agents and adult agents can operate the direct investment technology, but they differ in terms of their investment productivity. Both young and adult agents at time t know their own investment productivity for the current period. Young agents, however, do not know their future productivity at adult age. In addition to directly investing in the capital investment technology, agents have access to intermediated saving and to borrowing. Bubble assets will be held if two conditions are met: they provide competitive returns and remain affordable to future depositors. Introducing bubbles can have two effects: crowding-out, where low-productivity investors (young) turn into depositors and crowding-in, where high productivity investors (adults) have more internal funds. The global economy is defined as two regions: the North and

the South. Financial capital and output goods are free to move. Agents cannot move and physical capital must be used where it is produced. Financial markets integration can lead to bubbly dynamics in the global economy when two conditions are met: first, when globalization leads to financial development and, second, when there is a global shortage of assets.

Rondina presents a stylized equilibrium model of the global economy to study the conditions that translate into bubbles when financial markets integrate. In the global equilibrium with integrated financial markets, the bubble is held by the intermediaries and owned by the savers of the North and of the South. The model captures the allocation of the risk related to the sudden loss of value of the asset. In this model, a bubble is fueled by the demand of savers from the South, but in the end the savers in the North could end up holding the asset. Rondina argues that this is the type of global financial imbalance that developed during the real estate bubble of the early 2000's. ◊

Stable Near-Rational Sunspot Equilibria

George W. Evans and Bruce McGough

When it comes to modeling economic bubbles, the concept of sunspot equilibria is ubiquitous. These equilibria arise when extrinsic (as opposed to intrinsic) shocks influence agent behavior simply because other agents also condition on these shocks. In dynamic models with forward-looking agents, this can generate possibly many equilibria, all within the underlying notion of a "self-fulfilling prophecy." By far the most common lens with which to model forward-looking behaviors is rational expectations, but the question as to why agents form expectations using extrinsic shocks remains. One popular motivation for the "coordination" on these extrinsic variables is adaptive learning. That is, agents thinking that some extrinsic process might be important can lead to learning that the sunspots are, indeed, relevant.

Much work has been done on identifying the existence of sunspot equilibria in linearized models. Importantly, methods exist not only to identify these sunspots, but also characterize them in reasonably general environments (for example, when shocks are assumed to have continuous supports). While there are results that establish the existence of sunspots in non-linear environments, their characterization can be very elusive. Currently, no general technique exists to obtain these (in either closed form or numerically approximated) equilibria.

Notwithstanding the issue of existence, there are other difficulties when considering the stability of these sunspot equilibria with adaptive learning. Here, the authors highlight three such issues. First, it is not clear how to model agents' forecasting abilities, as non-linear models typically lack a recursive structure and are unreasonable to expect agents to use. Second, the existence of certain sunspot equilibria requires a "knife edge" assumption on the resonance of the extrinsic shocks. Third, and last, just as there are no general techniques to characterize these equilibria, there are no general stability results for them either.

The authors develop an equilibrium concept, dubbed "near-rational sunspot equilibria (NRSE)," that address the above points. Their paradigm models agents as boundedly rational, unable to obtain or process all information. In particular, the agents are assumed to use a linear forecasting rule when forming expectations. The authors prove that such behaviors in these non-linear models can be generally shown to generate sunspot equilibria and that they are natural generalizations of the corresponding linearized model (with the right resonant frequency). That is, the "knife edge" assumptions are simply because of the linearization, and are not more generally restrictive. Finally, due to the linearity of the forecasting rule, they establish some general stability results of the NRSE. For example, if the linear model is stable under learning, then the associated non-linear model with boundedly rational agents as described above is also stable.

This work by the authors is an important step in allowing study of sunspot equilibria in non-linear environments. The key in their equilibrium concept, the NRSE, is that agents are in some way boundedly rational, which is an arguably a reasonable imposition. A conference participant questioned, though, whether the NRSE were interesting in and of themselves, or if this modelling framework was simply informing the more general non-linear sunspot equilibria with rational expectations. The presenter explained that they were of interest themselves because they satisfy the cognitive rationality principle, and provide reasonable interpretations of results while still maintaining a rich, non-linear environment. ◊

Asset Bubbles and Foreign Interest Rate Shocks

Pengfei Wang, Jianjun Miao and Jing Zhou

The authors argue that from the experiences of several emerging markets in the past two decades and recent capital flow reversals, the stylized facts are the reversal of international capital flows, the sudden increase in net exports and the corresponding increase from large current account deficits to smaller deficits or smaller surpluses, declines in production

and consumption, real exchange rate depreciation, and a collapse in asset prices. The goal of the paper is to develop a theoretical model to understand the impact of foreign interest rate shocks on emerging economies.

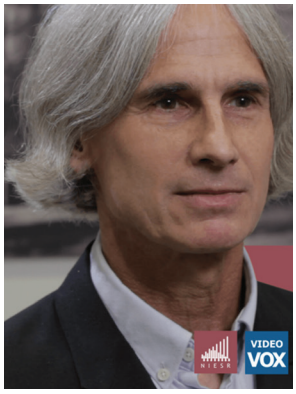
The theory is based on the collateral channel of the asset bubble. The authors propose an infinite-horizon dynamic general equilibrium model of a small, open economy in which there are frictions in both the domestic credit market and the international financial market. Firms can borrow from domestic and international financial markets. International financial transactions are intermediated by financial institutions or banks subject to portfolio adjustment costs. When the foreign interest rate is initially lower than the domestic interest rate, domestic firms finance their investment by selling bonds intermediated by banks to borrow from the foreign financial market. This can generate a low domestic interest rate and fuel a land bubble. If all agents believe that the intrinsically useless land has value, it can provide liquidity for firms to finance real investment. This belief can be self-fulfilling and results in a bubbly equilibrium. Since land is used as collateral, the existence of a land bubble can relax credit constraints. This allows efficient firms to borrow more and make more investment, which is known as the crowd-in effect. On the other hand, inefficient firms buy land from efficient firms and do not make real investment, which is known as the crowd-out effect. The net effect on aggregate investment and welfare is ambiguous. The authors show that there can also exist another equilibrium in which a land bubble does not exist.

When the foreign interest rate rises, capital begins to flow out of the domestic country. This generates a current surplus or a shrinking of the current account deficit. The increased supply of domestic goods in foreign markets leads to real depreciation, causing imports to decrease and exports to increase. Decreased imports lower output and, hence, investment and consumption. Meanwhile, investing in the international financial market crowds out resources for domestic firms to buy land. Moreover, payoffs from foreign bond holdings can also help provide liquidity to finance investments. Thus, demand for asset bubbles is weakened by capital outflows, and asset bubbles begin to fall. When the foreign interest rate is sufficiently high, asset bubbles can burst immediately. The authors show that the rise of the foreign interest rate has a much larger adverse impact on the domestic economy when there is an asset bubble than when is no asset bubble. This is because an asset bubble can help relax credit constraints. The crash of the bubble tightens credit constraints, causing investment by efficient firms to drop further. When this crowd-in effect dominates, aggregate investment declines significantly. As a result, the impact on output, consumption, real depreciation, and capital flows is much larger in an economy with asset bubbles.

The presenter addressed a concern raised by one discussant about a the choice of parameters in the model. Specifically, the discussant noted that there are two parameters which seem to serve the same purpose. The presenter answered that the introduction for both of the parameter is for tractability and not essential for the results. He also confirmed another discussant's observation that the change in the interest rate is permanent in the model. One discussant asked what in the model corresponds to specific details of emerging markets. The author noted that there was no specific characteristics in the model, but it is more reasonable to apply the model to emerging markets since the domestic country takes foreign interest rate as given. ◊

Examining the Sources of Excess Return Predictability: Stochastic Volatility or Persistent Investor Forecast Errors?

Kevin Lansing, Stephen F. LeRoy and Jun Ma



A vast literature examines the "predictability" of excess returns - that is, the ability of observable variables to reliably forecast future excess returns on stocks relative to default-free government bonds. The authors examine this predictability question from both a theoretical and empirical perspective.

From a theoretical perspective, the authors show that realized excess returns in a standard consumption-based asset pricing model can be represented by an additive combination of the representative investor's percentage forecast errors. As a result, the predictability of realized excess returns can arise from only two sources: persistent stochastic volatility of the model's fundamental driving variables or persistent investor forecast errors which imply a departure from fully-rational expectations. This is a general result that holds for any stochastic discount factor, any consumption or dividend process, and any stream of bond coupon payments. The authors then show that conditional variance of excess returns provides a measure of the stochastic volatility terms that drive predictability under rational expectations. As for the second source of predictability, the authors provide an analytical example to show how an investor who employs a miss-specified forecast rule can introduce predictability into her own percentage forecast errors. The example is the one in which the investor employs an AR(1) law of motion for consumption growth that ignores the stochastic volatility component or if the investor employs a naïve random walk for consumption growth.

From an empirical perspective, the authors investigate whether excess stock returns can be predicted using the previous period's excess returns, while controlling for persistent stochastic volatility in past returns and persistent stochastic volatility in consumption growth and dividend growth. The authors find evidence of predictability of excess returns from both sources. Specifically, the predictor variables that measure the volatility of returns or the volatility of fundamentals are often significant. But even after controlling for these sources of predictability, lagged excess returns can often be significant, suggesting that persistence in investor forecast errors is coming from a departure from fully-rational expectations.

One discussant asked the reason for not using forecasted returns but instead only analyzing realized excess returns. The presenter noted that Shleifer et al. looked at those data already. He also noted that another reason is the unreliability of survey data. The discussant then mentioned that the authors suggested evidence in support of their view from using survey data earlier, but did not use survey data for the empirical analysis due to unreliability. He asked whether this seemed inconsistent. The presenter acknowledged that comment, and replied that because there is no quantitative detail in the survey, they could not use it for empirical analysis. Another question was asked also about data source for the VIX dating from 1955. The presenter said that they construct a synthetic measure for VIX before 1990 by regressing VIX on realized volatility and lagged realized volatility. He added that the R-squared of the regression is about 90%. ◊

Asset Bubbles and Macro-Prudential Policy

Tomohiro Hirano

The authors note that there are two different views on how the government should react to asset price bubbles. One view is that it is better for the government to clean up crises after bubbles break rather than to interfere in a financial market beforehand. The other view is that the government should interfere in a financial market to lean against bubbles. The main purpose of the paper is to investigate which one of these views is more desirable from a welfare perspective in a dynamic macroeconomic model with rational bubbles.

The authors derive several main results. First, macro-prudential regulation can be justified in the case of over-sized bubbles, which are more likely to occur when the quality of the financial system is relatively high. Second, although macro-prudential regulation reduces the over-sized bubbles, it may end up increasing boom-bust cycles in real variables. Third, when the degree of externality - namely, interconnectedness in production - is large a bailout policy can improve taxpayers' welfare, but it creates a time-inconsistency problem if the government cannot commit to it, thereby generating welfare losses. Macro-prudential regulation can mitigate the welfare losses arising from the commitment problem. Under some conditions, macro-prudential regulation can function as a commitment device. Moreover, even if the government can commit to future bailout policy, macro-prudential regulation can mitigate welfare loss associated with commitment equilibrium, thus increasing taxpayers' welfare. The authors argue that these findings provide a theoretical foundation of the case for "lean against the bubble" policies, as well as for "clean up after" policies.

One discussant asked why the borrowing constraint is multiplied by a number less than one. The presenter noted that if the model has infinitely lived agents, it needs a fraction of the collateral in asset possession to satisfy the transversality condition. The presenter also mentioned that once the bubble bursts, there is only redistribution within the same period. Another discussant inquired about the origin of bubbles in the model. The presenter replied that every agent in the model owns one unit of bubble in the first period. Another question was raised about whether it is essential for welfare analyses to assume that only the entrepreneurs hold bubbles. After the presenter acknowledged that he was not sure about the answer, the discussant asked where it matters to have the increasing return-to-scale assumption that is proposed in the model. The presenter mentioned that it is present in the heterogenous agents case, but was not certain whether it is essential for generating the shape of the growth rate and bubble size in the model. The presenter later confirmed a discussant's intuition that the economy is always on the balanced growth path. The discussant then asked why there are no transitional dynamics, given that when the capital collapses there is confusion about which state variables are relevant. The presenter noted that the paper employed log utility so that only initial capital level matters. One discussant noted that the model forces the tax on the asset side, and he wondered why the authors did not employ leverage change instead. The presenter answered that introducing the leverage change could affect both bubble and bubbleless economy. ◊

On Interest Rate Policy and Asset Bubbles

Gadi Barlevy, Franklin Allen and Douglas Gale

Gadi (2014) studied the effect of higher interest rates when a bubble is present and found that a higher rate will paradoxically make the bubble larger. In the present paper, the authors try to analyze what Gadi's model may be missing. They first note that Gadi suggested policymakers may worry about irrational exuberance while his model features rational agents. Moreover, they argue that Gadi's model misses something more fundamental. Specifically, the agents acting to raise rates might crowd out spending on the bubble asset. This is because higher rates may induce a recession, leaving agents with less to invest. Also, higher rates may require the public to hold bonds instead of assets. The authors show that Gadi's setup abstracts from this possibility. Specifically, they show that Gadi's model restricts how rates affect output and income in certain ways. They also show that Gadi assumes that the bubble asset is the only financial instrument. For example, in his model, there is no government bonds. Once the model is modified, the results of Gadi's model are overturned.

To gain insight, the authors first replicate a version of Gadi's model. Importantly, there are two assumptions on the asset agents' trade. The first is that agents can, in effect, only trade one asset. The second assumption is that the asset is intrinsically worthless. Thus, the initial price of the asset affects the bubble size. In this setup, the authors show that Gadi's assumption that the initial price is the same for all interest rate paths is redundant because the equilibrium model disciplines the initial price. This means that across equilibria, the initial price and the initial interest rate are related. Specifically, if the initial interest rate is positive, the initial price is unique. And in general, a higher initial interest rate implies a weakly higher initial price. This means that when choosing higher rates, the model essentially implies a larger bubble. The intuition is that if the interest rate is higher, the agents move from storage to assets. With only one asset at a fixed supply, the influx of resources will drive up the price.

The authors then show that this logic need not extend to an environment with more than one asset. Specifically, the authors modify the model by adding government bonds. The key result is that an increase in outstanding debt at each date will lead to higher interest rates and lower asset prices, which is consistent with conventional wisdom and also overturns Gadi's result. The intuition is that bonds crowd out resources that would have gone to assets, and that interest rates rise as price falls while dividend remains unchanged.

The authors then conduct a welfare analysis. The example they provide involves changes in fiscal policy. They show that with flexible prices, a policy that drives initial money prices down lowers the initial asset price. The intuition is that higher outstanding nominal liabilities force the government to issue more debt, which crowds out resources from the asset, but interest rates will not rise unless taxes do. The authors then add a sticky price to obtain higher interest rates with fiscal policy. They show that tight monetary policy can raise rates and reduce bubbles.

One of the discussants asked whether the results of the presenter's replication of Gadi's model relies on the assumption that the dividend yield is zero. The presenter confirmed the guess, but noted the equivalence to Gadi's original model. Another question was raised about the reason behind a zero-interest rate in equilibrium. The presenter answered that this corresponds to the bubble-less equilibrium. One discussant asked the reason for keeping the bond when conducting a fiscal policy analysis. The author noted that they wanted to show that monetary policy by debt insurance can reduce the bubble. ◊

Efficiency and Policy in Models with Incomplete Markets and Borrowing Constraints

Rishabh Kirpalani

The author notes that a large and growing literature in macroeconomics and international economics uses models with markets and financial frictions for a variety of quantitative and policy exercises. The key assumption in these models is that markets are exogenously incomplete. Most of these models make one of the two assumptions, the first being that agents can trade an un-contingent, risk-free bond subject to exogenous debt constraints, the second being that agents can trade defaultable debt contracts. The paper takes an alternative view to relax the exogenous incompleteness assumption and consider general contracting environments in which no restrictions are placed on the types of contracts agents can sign. The author shows that the informational and commitment assumptions exist that endogenously generate the types of contracts assumed by much of the applied literature. He also shows that the best equilibrium in these environments is efficient, and that models with endogenous incompleteness have substantially different implications for policy than those with exogenous incompleteness.

The author studies a dynamic environment with a large number of risk-averse households who receive stochastic endowments each period and seek to share risk with each other. The contracting environment is subject to three key

frictions: private information, voluntary participation and hidden trading. The author shows that the equilibrium outcomes in this environment are equivalent to those in a standard incomplete markets model in which households trade a risk-free bond subject to debt constraints. Moreover, these debt constraints are independent of households' histories and thus look exactly like those assumed in models with exogenous incompleteness.

The second main result of the paper is that the best equilibrium in this environment is constrained-efficient. The author shows that in the presence of hidden markets, the amount of state contingency a planner can offer in a contract is severely limited. As a result, the planner cannot do better than offer short-term uncontingent contracts. In addition, transfers are further limited due to the interaction of hidden trading and voluntary participation.

The third set of results concern the lessons for policy. The first implication is that policies which might be considered desirable when markets are exogenously incomplete, may no longer improve welfare when markets are endogenously incomplete. In particular, outcomes in models with exogenous incompleteness are typically inefficient. The second implication is that, because of the multiplicity of equilibria, there is an important role for policy to uniquely implement the best equilibrium. A final point is that all three frictions are essential to the nature of the contract.

One discussant asked whether participation is an absorbing state. The author confirmed this observation, noting that a well-known feature of these environments is that risk-sharing is possible only if households that do not repay their debts suffer a cost. He does so by assuming that if the households do not repay their debts, they are permanently excluded from financial markets and forced into autarky, which makes participation an absorbing state. Another discussant asked whether it is true in the model that if the agent defaults on one of the contracts, it is the same as if she defaults in all contracts. The author replied that since default is publicly observable, this is indeed the case. He also noted that the efficiency analysis results indicate that the planner cannot change default behavior. ◊

Excess Volatility: Beyond Discount Rates

Stefano Giglio and Bryan Kelly

The authors document a form of excess volatility in term structure prices that is irreconcilable with "standard" asset pricing models. The central finding is that price fluctuations at different points in the term structure are internally inconsistent with each other. Specifically, prices on the long end of the term structure vary far more than what is justified by the behavior of short end prices, given usual modeling assumptions. The main empirical finding is that in all asset classes examined by the authors, long maturity prices overreact to short maturity. The consistency violations are highly significant, both statistically and economically. The authors find that excess volatility of long maturity prices is evident in a large number of asset classes, including claims to equity and currency volatility, sovereign and corporate credit default risk, and inflation. Only for the term structure of treasuries do they find that violation of the no arbitrage restrictions is economically small, consistent with the findings of a large literature on term structure models.

The authors examine four potential explanations for the excess volatility of long maturity claims: omitted factors, non-linear dynamics, long memory dynamics, and violations of no-arbitrage. First, they show that the omitted factors are unlikely to explain their findings because an unrestricted factor model explains more than 99% of the variation in each term structure they study. It is thus quantitatively infeasible for a model with too few factors to generate a variance ratio far above one while at the same time producing an unrestricted R-squared over 99%. Second, the authors explore a large class of non-linear dynamic specifications known as smooth-transitioning autoregressive models. In most parametrizations, the models are very closely approximated by a low-dimension affine model and therefore do not produce variance ratios above one. For the most extreme non-linear specifications, it is possible to generate variance ratios that statistically reject the affine restrictions - but even in these cases, the variance ratios are substantially smaller than those found in the data. Third, the authors explore a wide range of long memory models that fall into the stationary ARFIMA family. The vast majority of ARFIMA specifications appear well-approximated by simple affine models and do not lead to high variance ratios. However, as the ling memory parameter reaches the boundary of the non-stationary range, the authors show that it is possible to generate variance ratios as high as three at the 24-month maturity while at the same time producing unrestricted factor model R-squared values above 99%. Fourth, the authors show that the investor overreaction leads to no-arbitrage violations that produce high variance ratios at long maturities similar to those in the data. However, the authors show that, in some ways, long memory behavior and arbitrage violations induced by overreaction are observationally equivalent. To disentangle this ambiguity, the authors construct a trading strategy that helps distinguish between alternative explanations for excessive volatility, namely a miss-specified econometric model on the one hand versus genuine mispricing on the other. If the true data-generating process does not admit arbitrage, then the trading strategy will perform poorly, which is the case in simulation. However, in the variance swap market,

they find that the strategy is highly profitable, suggesting that at least part of the violation is due to arbitrage opportunities arising from investor overreaction at the long end of the term structure. The authors then show that the trading strategy returns are unexplained by standard risk factors or by exposure to factor risk in the variance swap term structure, which further supports the overreaction interpretation of the results.

One discussant asked whether the model implies zero interest rate. The presenter agreed with the implication but explained that it is not an important assumption because the model already discounts the prices. Another discussant asked why the error term in the model does not matter. The author replied that this is because the pricing function is an expectation which eliminates the error term. ◊

Bubbly Recessions

Toan Phan, Siddartha Biswas and Andrew Hanson

An interesting puzzle in the bubbles literature is that nominal and real wages do not decline when a bubble collapses. A prominent example is that in Japan after the asset price bubble collapse, real wages remained quite high. To investigate this phenomenon, the authors explore the interaction between a frictional labor market and risky asset bubbles.

The authors' model consists of entrepreneurs, workers, and firms. The entrepreneurs in the model have idiosyncratic shocks over the production of a capital good. The entrepreneur can either meet a high- or a low-productivity investment project. The entrepreneurs face a credit constraint, à la Kiyotaki-Moore, and can also trade a bubble asset. This bubble asset has a constant probability of collapsing. When it has collapsed, it does not re-emerge. The workers are hand-to-mouth and firms hire workers to produce a single perishable good. Finally, there exists a labor market friction: downward wage rigidity. Because of a rigid wage, the labor market does not necessarily clear.

The government also plays a role, in that their macroprudential policy can impose a tax to mitigate the losses. One participant commented on the modeling of the macroprudential policy, suggesting it is a financial trading tax, like what has been proposed in France. Another participant explained that this is the way macroprudential policy is modeled in the literature, and the terminology is appropriate.

The bubble has two competing effects on investment. First, the bubble crowds in investment by raising an entrepreneur's net worth. Second, the bubble crowds out investment, because some of the entrepreneur's resources will be invested into the bubble asset. The size of the "crowd in" effect is greater than the "crowd out" effect, and thus the asset increases investment. An asset bubble exists if and only if there is a sufficiently large financial friction and the bubble asset is a sufficiently safe asset.

One participant asked how this model is fundamentally different from a model with collateral constraints. In particular, how could this situation be distinguished from empirical work where there is an exogenous tightening of collateral? Another participant clarified the circumstances that brought about the bubble in the first place - specifically, if the shock is unanticipated, is it irrational?

After establishing the model and equilibria with and without the bubble asset, the discussion turned to comparative statistics. Because everything has been solved analytically, the authors can completely characterize the post-bubble dynamics. First, the slump duration is a function of the wage rigidity, such that longer wave rigidity is associated with a longer slump. One participant asked if the authors could make a statement about the relationship between the magnitude of the output rise and the bust. For example, if the output was higher during the boom, would the bust be worse? The authors stated that the answer is yes, and that the slump duration would be longer as well.

There were some concerns about whether the drop in employment was mechanical, since employment cannot be greater than full employment. One participant recommended adding in a disutility of labor. Another participant recommended allowing the bubble not to "burst" but instead merely deflate.

The welfare implications of the bubble for workers are also clear. With no tax - and a wage rigidity that prevents the real wage from declining - the bubble will strictly reduce welfare. One participant recommended including welfare of the entrepreneurs in this calculation as well. Another participant asked which tool, the inflation rate or the macroprudential policy, would be better in this situation. The model currently does not include a cost of inflation, which will be for future research.

The newest part of the paper introduced a potential liquidity trap as a result of the bubble bursting. To microfound the zero lower bound, entrepreneurs choose a cash holding. When the bubble bursts, the interest rate overshoots, causing a liquidity trap. The liquidity trap only lasts one period, as in prior literature. The deflated price level exacerbates the wage rigidity.

Another participant suggested the cash in advance could be held as collateral. If that was the case, it might mitigate some of the effect of the bubble bursting. ◊

Asset Bubbles and Monetary Policy

Jianjun Miao, Feng Dong and Pengfei Wang

There has been an extensive debate on whether monetary policy should respond to asset bubbles. One argument suggests that central banks should raise interest rates or decrease money supply to deflate a potential bubble. This policy, referred to "leaning against the wind," has been suggested in the literature. The other viewpoint, that price stability and financial stability are highly complementary and mutually consistent objectives, argues that central banks should not respond to asset prices. This viewpoint is also supported by the idea that any potential welfare gains are small. The debate has been limited because the rational bubble literature lacks a theoretical framework. Here, the authors connect to the mainstream macroeconomics literature by creating an infinite horizon model of rational bubbles in the Dynamic New Keynesian (DNK) framework. Using this framework, the model answers three important questions: how asset bubbles affect the real economy, whether monetary policy leads to asset bubbles, and how monetary policy should respond to asset bubbles.

The bubble arises in this context because entrepreneurs are heterogeneous in their investment efficiency and face a credit constraint. Asset shortages with credit constraints create an environment where an intrinsically useless asset can provide liquidity. Combined with a banking system with legal regulations to have reserve requirements, this creates a wedge between the lending rate and borrowing rate. The bubble's benefit, in this framework, is improving investment efficiency. The bubble's cost is excessive volatility. In contrast to an overlapping generations model (e.g., Gali, 2014), the authors treat asset bubbles as a forward-looking non-predetermined variable like any asset price.

To create asset bubbles that fluctuate in size, the model contains two assets. With constant returns to scale in production, an entrepreneur has two cutoffs related to the inverse of Tobin's q. The first cutoff determines the investment or saving decision. Then, conditional on investment, there is a decision to borrow additional funds. This liquidity premium is necessary for the existence of bubbles in an infinite horizon model framework. Without a liquidity premium, the transversality condition rules out bubbles. This condition is not needed in overlapping generations models with finitely lived agents (e.g., Gali, 2014). Furthermore, this liquidity premium is endogenous to the model. In addition to entrepreneurs, the remainder of the economy is comprised by retailers, workers, bankers, and the government. With an equilibrium, the authors then move to the role of monetary policy in affecting the conditions for the existence of a bubble.

The model shows that the higher the inflation rate, the more likely a bubbly steady state can exist. This is because an increase in the inflation rate decreases an entrepreneur's net worth. To keep the aggregate investment rate equal to the depreciation rate, more firms must make investment, causing the liquidity premium to rise. This partially comes from the existence of the reserve requirement.

After establishing this result, the paper moves to discussing how monetary policy should respond to asset bubbles. The authors calibrate their model and begin to shock the economy to see what happens. They consider two types of shocks: a fundamental TFP shock and a non-fundamental sentiment shock. The monetary policy choices are two types of interest rate rules: a Taylor rule and an inflation targeting rule.

The calibration and resulting impulse response functions showed an important difference between DNK and DSGE models. In DNK models, labor can drop as a result of a positive sentiment shock. This is because interest rates rise and consumption falls on impact. Therefore, the welfare gain from imposing a Taylor rule to respond to sentiment shocks is approximately a 2.45% increase in consumption. A Taylor rule to respond to TFP shocks has small welfare gains, and strong inflation targeting rules have welfare gains that approach zero. This is consistent with the findings from Bernanke and Gertler (1999). One participant asked Professor Miao to clarify if this was opposite of "leaning against the wind." He responded that this was indeed the case. This is because there is an inverse relationship between bubble volatility and inflation volatility. While "leaning against the wind" might reduce bubble volatility, this could come at the cost of raising inflation volatility.

The paper makes many key contributions, perhaps the most important of which is the finding that whether asset bubbles are treated as forward-looking or backward-looking is critical for understanding their dynamics. Further, it models the interactions between financial frictions and asset bubbles, and also provides a foundation for the conventional wisdom on the role of monetary policy in managing asset bubbles. While the policy implication is the same as the Gali (2014) model, it is for a different reason.

One participant suggested future work where bubbles can be negative, as opposed to positive, may be valuable. ◊

Fourth Annual Macroeconomics and Business CYCLE Conference Participants
May 2017

Raphael Abiry – SAFE, Goethe University
R. Anton Braun – Federal Reserve Bank of Atlanta
Christine Braun – UC Santa Barbara
Dan Cao – Georgetown University
Rui Castro – University of Western Ontario
Alessandra Fogli – Federal Reserve Bank of Minneapolis
Paul Gaggl – UNC Charlotte
Dana Galizia – Carleton University
Carlos Garriga – Federal Reserve Bank of St. Louis
Aspen Gorry – Utah State University
Grace Weishi Gu – UC Santa Cruz
Aaron Hedlund – University of Missouri
Sewon Hur – University of Pittsburgh
Finn Kydland – University of California, Santa Barbara
Serdar Ozkan – University of Toronto
Ander Perez-Orive – Board of Governors
Peter Rupert – University of California, Santa Barbara
Immo Schott – University of Montreal
Colin Ward – University of Minnesota
David Wiczer – Federal Reserve Bank of St. Louis
Noah Williams – University of Wisconsin-Madison

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

Secular Stagnation? Growth, Asset Returns and Welfare in the Next Decades: First Results

Raphael Abiry, Christian Geppert and Alexander Ludwig

What are the effects of an aging population on economic growth? Ongoing experiences with such trends in the United States and Japan, to name two, make this a particularly important issue. Since this phenomenon develops gradually over time, the economic effects of concern are secular, as opposed to cyclical. Thus, addressing these issues likely requires policymakers to focus on longer-term remedies that fundamentally address the consequences of aging societies. For instance, aging populations may be associated with relatively lower production, which may affect returns and, thereby, investment and capital.

The authors study this topic with a focus on the US economy over the next few decades. They ask how demographic change will affect growth through the lens of an overlapping generations model with features that realistically capture the process of aging as generations turn over. With this they can investigate whether reductions in growth are accompanied by meaningful declines in the real rates of return, which are specifically distinguished in the model by allowing there to be both risky and safe assets. Although aging is generally associated with predictions of a relative shortage of labor (or equivalently a relative abundance of capital) which will lower returns on (and investment in) assets, this may impact different groups in different ways. Older generations, for instance, may be less inclined to take on risk and so may increase their demand for safer investments. Finally, the authors address questions of policy prescriptions by exploring the role of human capital investments to counteract declines in the aggregate provision of raw labor. That is, they consider policies to promote the attainment of human capital to augment the effective labor input.

The model the authors use features both idiosyncratic and aggregate shocks with households endogenously choosing the labor input through risky period-by-period investments in human capital. They also solve a standard portfolio problem to invest in risky physical capital and a riskless one-period bond. Their setup of functional forms and timing produce policy functions that enable solving a reasonably large-scale model with interesting dynamics. Demographics in the model are exogenously driven: households enter the model at age 20 and live until 101 at most. Young households give rise to new households probabilistically, and similarly have some probability of exiting the model. When a household dies, its remaining wealth is taxed at 100% and used for government consumption.

Using fertility and mortality profiles calibrated to hit the cross-section of households across age in 2010 and to be consistent with an aging US population moving forward, the authors find a reduction in cumulative output in 2035 of 6% relative to a constant growth scenario. This is associated with a projected decrease in risky (risk free) returns by 0.7 (1.0) percentage points. That is, the model predicts an increase in the equity premium, hitting the older generations the hardest, considering their proclivity for less risky portfolios. Though not modeled explicitly, the authors argue that this suggests an opportunity for governmental policies aimed at incentivizing investment in human capital, which would increase the effective labor input and offset some of these results.

A conference participant noted one issue with the model centered around the stylized fact that households accumulate wealth well into their retirement phase (which is taken exogenously), stemming from strong motives for bequests. In the absence of this feature in the model (any left-over wealth when a household exits the model is lost) then the model would likely have incorrect predictions about the portfolio choices of aged households. That is, older households may indeed be inclined to invest in riskier assets insofar as that enables them to give more to their children. The presenter noted that the concern was valid, but that their model presently was incapable of addressing such concerns. ◊

Capital Misallocation and Secular Stagnation

Ander Perez-Orive and Andrea Caggese

In past decades, real interest rates have decreased while economic growth has fallen short of previous trends. This has been linked to a process of secular stagnation. Concurrently, the developed world has experienced technological changes including an increased importance of information technology and knowledge, human and organizational capital, and a reduced reliance on physical capital. The authors argue that the increased reliance on intangible capital and the low interest rate interact to hurt capital reallocation and to reduce productivity and output growth.

Aggregate productivity relies on an efficient reallocation of resources from declining firms to expanding firms. The increase in intangible capital then implies a growing importance of

the reallocation of intangible assets including patents, brand equity, and human and organizational capital. This type of asset cannot be collateralized and their acquisition must be financed mostly using retained earnings. Consequently, the corporate sector borrows less, holds an increasing amount of cash, and switches from being a net borrower to a net saver. The price of these intangible assets increases as interest rates decrease, thus reducing the ability of credit-constrained expanding firms to purchase them. Lower interest rates also decrease the rate at which non-investing firms can accumulate savings to finance future expansions. The authors show that the rise in intangibles alters the relationship between interest rates and efficiency in the allocation of capital.

The authors develop a model in which firms use tangible capital, intangible capital, and labor as complementary factors in the production of consumption goods. There are two types of firms: high productivity and low productivity. High productivity firms are financially constrained and only invest occasionally, while the low productivity firms are unconstrained. The household sector is modeled as overlapping generations, where young households work and receive dividends and old households only receive dividends. The authors calibrate and simulate the full general equilibrium model to study how developments in the household and corporate sectors have interacted to produce patterns consistent with the secular stagnation hypothesis. In the household sector, the authors model a progressive decrease in individuals' rate of time preference and a progressive increase in their life expectancy, both of which put downward pressure on the equilibrium interest rate. In the corporate sector, the authors model a gradual shift in the firms' dependence on intangible capital.

The authors find that both the household and the corporate sectors are expansionary in isolation, but the combination of both developments is contractionary. While firms still rely strongly on tangible capital, the drop in the interest rate increases high-productivity firms' ability to borrow and pay down their debt. As firms shift towards more intangible capital, they become net savers. Low rates reduce efficient capital allocation by increasing capital prices and by slowing the accumulation of corporate savings. This causes the share of output produced by the high-productivity firms to drop significantly. The reduced corporate borrowing also puts downward pressure on interest rates, which amplifies the misallocation of capital. In conclusion, the authors note that changes in firms' financing behavior due to technological change might help explain the subpar growth associated with secular stagnation. These changes in firms' behavior interact with low interest rates behind secular stagnation to amplify negative effects. ◊

Male Labor Supply and Generational Fiscal Policy

Aspen Gorry, Eric O'N. Fisher and Christian vom Lehn

Between 1948 and 2000, hours worked per person by men in the US fell by 20 percent. The decline is largest among young and old workers and more prominent on the extensive margin. The authors evaluate how much of the decline in male labor supply can be explained by changes in taxes and transfers policy. They use a version of the life cycle labor supply model of Rogerson and Wallenius (2009) — featuring both intensive and extensive labor supply decisions — to construct life cycle labor supply for separate birth cohorts of males from 1900 to 1950. Generational accounts estimate total present discounted value of net tax payments of past and future generations by gender. The authors find that changes in policy and age demographics explain 44 percent of the decline in hours worked from 1948 to 2000.

Using generational accounts to estimate the present discounted value of net tax payments, the authors construct lifetime tax and transfer rates for males as a percent of lifetime labor income. The authors then use rates from Auebach et al. (1993) to construct a standard tax wedge and plot changes in tax and transfers independently. To model life cycle labor supply decisions, the authors construct a model based on the setup of Rogerson and Wallenius (2009). The individual, who lives for one unit of time, chooses a lifetime consumption plan, and whether and how much to work at each date.

The representative agent for each cohort lives for one unit of continuous time in the model, so this continuous time must be mapped into discrete ages. The authors assume each agent lives from ages 16 to 80 to construct each cohort's hours worked at each age. The model is calibrated using the wage profile to match the observed life cycle hours profile for the cohort born in 1940 and this profile is held constant for all cohorts. Simulations measure the importance of changes in taxes and transfers on labor supply for this baseline wage profile. The population is grouped into age bins because of data limitations and the model's stylized cutoffs. The model accounts for about 70 percent of the decline through 1970 and 44 percent of the decline through 2000. The model is primarily accounting for the changes among younger and older workers. Using a standard decomposition, the authors separate the effect due to demographic shifts and the effect due to fiscal policy. The authors find that broad demographic change was more important through 1970 and irrelevant through 2000.

The calibrated life cycle labor supply model explains 44 percent of the decline in male labor supply from 1948 to 2000, more for young and old workers. Holding demographics fixed, the model still explains 25 percent of the total decline. Using tax wedges from generational accounts complements existing tax wedge measures and provides a way to analyze the effects of fiscal policy on labor supply. ◊

Putting the Cycle Back into Business Cycle Analysis

Dana Galizia , Paul Beaudry, and Franck Portier

In current business cycle models, the underlying economic structure exhibits a high degree of stability. Indeed, most modern models exhibit convergence to a steady state or balanced growth path. In order to generate business cycles, these frameworks rely on exogenous shocks to perturb the system. The authors challenge the current business cycle theory consensus by re-exploring the concept of stochastic limit cycle models. In doing so they develop a model wherein booms sow the seeds of busts, causing the economy to display cyclical behavior rather than convergence to a steady state or balanced growth path.

Before developing their model, the authors document several empirical regularities. In particular, they investigate the spectrum of factor utilization measures and find that non-farm business hours per capita, the unemployment rate, and the capacity utilization rate exhibit significant volatility around a frequency of 40 quarters. Hence, they argue that the upper bound of what is considered a business cycle should be extended from 32 quarters to at least 40 quarters. Based on these spectral peaks in the aforementioned measures, the authors conclude that business cycle theory may require a strong cyclical mechanism.

As a first pass, the authors develop a reduced form model in which there is no agent intersection. Instead, agents accumulate capital through investment where the investment decision of each economic actor is independent. In such a simple model, the economy displays monotonic convergence to a steady state. The authors show, however, that once the investment decision of each agent also depends on the average level of investment in the economy, a deterministic limit cycle emerges under appropriate parameterizations. Indeed, under this framework, stretches of high capital accumulation are followed by periods of low capital accumulation.

After a thorough review of bifurcations and limit cycle theory, the authors build a model to take to the data. In their model, workers must borrow to buy a consumption good prior to learning whether or not they will be unemployed. The borrowed funds are paid back if the worker is employed or is bailed out by other members of their household. Thus, these loans by the banking sector can be either costlessly or prohibitively costly to recover, each with some positive probability. Here, firms hire workers in a frictional labor market based on aggregate demand. Finally, households discount the future at some stochastic rate. The authors calibrate this model to match the spectrum of hours worked per capita and the risk premium. Their calibration is, in fact, able to match the hours and risk premium spectra, as well as produce stochastic limit cycles in hours worked for a sample draw of shocks.

Several in the audience were concerned with the authors' focus on factor utilization as a measure of business cycles. They argued that redefining the business cycle and fitting your model to these new facts is not an appropriate comparison to the existing literature. Moreover, other conference participants were concerned with the extension of what is considered as part of the business cycle beyond the current 32 quarter standard. They too argued that "moving the goalpost" to fit your model is inappropriate. ◊

Equilibrium Wealth Share Dynamics

Colin Ward, Ravi Bansal and Amir Yaron

Sectoral wealth, or wealth share of each sector, shifts over time and alters the distribution of risks and asset returns. The authors argue that the primary movements in wealth shares are affected by changes in hedging demand and not by mean-variance tradeoffs, a feature commonly over-looked in the literature. The authors suggest that in order to understand the complete picture of investors' asset allocations, we should be foremost uncovering the nature of hedging demand by analyzing which assets are held to hedge against what risks and why, and not only be measuring expected returns or variances.

In an economy where investors use mean and variance for their portfolio choice, the implications are that prices and some moments of the assets' return distribution must adjust if an assets' market value increases. A production economy would further predict that Tobin's Q should fall as risk premia rise. These basic predictions run counter to two empirical facts: risk premia relates negatively (or does not relate) to wealth shares and Q positively correlates with wealth.

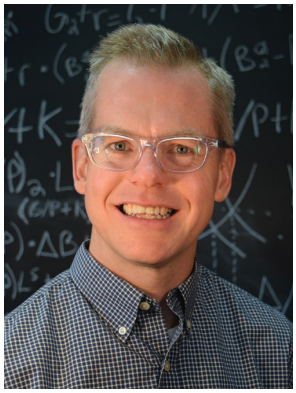
To investigate these, the authors analyze a two-sector economy, where there are two Lucas trees with production. The authors first allow the two dividend streams to be imperfect substitutes. A relative price between the two streams then fluctuates endogenously, changing the distribution of risk and return across assets. The authors then include shocks to demand that are independent of the usual endowment or supply shocks, capturing the idea that preference for these two types of goods fluctuates over time.

In the calibration, the authors find that including these two elements is necessary to capture the two empirical facts. First, by calibrating solely to observed fluctuations in supply, the model cannot easily generate a negative relationship between a sector's risk premia and wealth share. The basic reason is that as an asset's wealth shrinks, its contribution to aggregate consumption falls, bringing shocks to its cash flows closer to being idiosyncratic and lowering its required return to the risk-free rate. The model breaks this positivity by making marginal utility especially sensitive to demand shocks when supply is scarce. Second, an increase in a sector's supply, all else equal, would decrease Tobin's Q. Demand shocks break the mechanical result by opening the possibility of a sector's risk premia falling for a given supply, pushing both its Q and wealth up. The inclusion of demand shocks, in addition, helps the model describe the commonly studied joint behavior of consumption, investment, and cash flows. Finally, the authors evaluate the model by matching one sector to business wealth, essentially the total market value of debt and equity across financial and nonfinancial sectors, and the other to housing. The authors then use the model to invert a process for demand shocks between business and housing capital by using the model's cross-equation restrictions on the distributions of capital and wealth. Given the implicit process for demand shocks, the authors find that hedging demand constitutes the majority of a sector's wealth share dynamics.

One discussant inquired about the data source, and the author answered that it is taken from BEA's aggregate data. Another discussant asked what would the implication be if a large share of the wealth is owned by a small fraction of people. The author replied that the current version of the model only looks at a representative agent with no labor decision. He also noted that the model does not include private capital. One discussant observed that in the model the stochastic demand shock is mean-reverting, and he wondered whether it is essential. The author noted that as long as the shocks are stochastic it will give similar implications. This is because the adjustment cost is causing the price to be sensitive, which drives persistence. ◊

Optimal Contracts with Hidden Risk

Noah Williams and Rui Li



The authors study the incentive to manage risk and show how it interacts with performance-based contracts. Classical moral hazard problems in economics and corporate finance generally focus on hidden actions: managers can shirk and not put forth effort, or they may be able to divert resources from the firm for their own private benefit. Such agency frictions motivate performance-based pay contracts, which align the incentives of owners and managers. However in some situations, managers may be able to take on excess risk which is unobservable to firm owners, for example by loading up on tail risk by making futures bets or selling insurance against unlikely events. The firm owners would observe the increased cash flows from the insurance or risk premiums, which they would interpret as good firm performance, worthy of reward for the managers. But the owner would be unaware of the potential future losses. The authors develop a model which incorporates this tension between performance pay and risk-taking. They show how owners can provide incentives to discourage excess risk, but also that it may sometimes be optimal for owners to forgo risk management and let managers gamble the firm's assets.

In the model, an owner hires a manager to manage her firm's assets over an infinite time horizon, and both parties are risk averse. Moral hazard arises because the manager could divert the firm's resources for his own consumption, and this behavior is indistinguishable from random cash-flow shocks. In addition, the manager can take unobservable actions which yield risk-free current payoffs, but expose the firm's assets to large risks. The author model this as the manager controlling the arrival rate of a jump process which a negative impact on the firm's capital when it occurs. The firm's overall exposure to the shock has a zero mean, so the occasional large negative shock is offset by a positive flow income. If the manager were to increase the arrival rate of the shock, they make large losses more likely, which was unobservable to shareholders. Prior to arrival of a negative shock, the shareholders observe the cash inflow resulting from the risk compensation. However, the shareholders would attribute these flows to stronger cash flows from good performance, and thus would reward the manager. In other words, a contract which is optimal for the standard moral hazard friction of preventing diversion, but ignores the risk-taking incentives, will closely tie the manager's compensation to the firm's performance, and so may induce him to take on excess risk.

The optimal contracts must balance the incentives to alleviate the moral hazard friction and to manage risk, and the authors show that in some cases the owner optimally gives up on risk management. It may be too costly for the owner to provide sufficient incentives for the manager to take prudent actions, so instead the owner focuses on preventing resource diversion. Rather than being a failure of corporate management, it may be a feature of optimal contracts that managers subject their firms to excess risks, which would be undesirable in the absence of private information frictions.

Under the additional assumption that the owner and the manager have exponential preferences, the authors show how the optimal contract can be implemented with some simple instruments. In particular, the owner gives the manager a constant salary payment and access to an account which represents the cumulation of his bonus or deferred compensation, and the balance on this account increases with the firm's assets. To provide incentives to manage risk, the contract also features a "clawback" provision in which the manager loses part of his deferred compensation in the event of a negative jump shock.

One discussant asked whether the owner observes the arrival rate of the shock, mentioning that without knowing the exact parameter values the owner cannot solve the model. The author noted that the owner cannot observe the arrival rate. Rather, she recommends an optimal arrival rate of the shocks and use other instruments to ensure that the contract satisfies the incentive constraint. ◊

Simulative Effects of Temporary Corporate Tax Cuts

Rui Castro and William Gbohoui

The goal of the paper is to quantify how effective temporary corporate tax cuts are at raising business investment and output. Temporary corporate tax cuts are a popular tool for policymakers acting to promote investment in times of recession and have been included in recent stimulus packages, including in the 2003 Bush tax cuts, 2010 Obama tax cuts, and the 2009 Canadian Economic Action plan.

Past relevant literature has focused on the intertemporal substitution channel provided by temporary corporate tax cuts (i.e. the fact that firms, knowing that the tax cut is temporary, concentrate investment in the period of lower taxation). Rather than look at this channel (otherwise known as the distortionary effects of taxation), the authors instead focus on the role of temporary tax cuts in alleviating financial frictions (i.e., the tax relief channel). If a firm's access to credit is tight during recessions, these tax cuts may increase a firm's access to external funds.

To quantify these tax effects on constrained firms, the authors specify a general equilibrium model that consists of all-equity firms, a representative household, and a government entity financed by debt and lump-sum corporate taxation. The presenter describes the model as a "Ricardian Equivalence experiment," as there exists as "Ricardian benchmark" in which the absence of financial constraints renders changes in lump-sum taxes as having no stimulative effects.

In addition, all firms face idiosyncratic productivity shocks and entry/exit shocks. This model departs from the world described by the Modigliani-Miller theorem via the financial frictions that are introduced. There is an upper bound on the amount of external funds a firm has access to, as well as a minimum dividend payout policy that a firm must adhere to. The lump sum tax affects the investment decision of the firm by further limiting the amount of external funds the firm has access to. This is nicely shown in the investment Euler equation that the model produces.

The authors solve the model with numerical methods, computing the pre-tax cut steady state and the post-tax cut steady state (after the tax cut has expired). They also use backward induction to find the transitional path of the economy when the tax cut is in effect. To demonstrate, let time 0 be at the pre-tax cut steady state, time 1 be the time of the tax cut, and time 2 be the expiration of the tax cut. Taxes remain constant for time 3 and thereafter. Agents are aware of this timing in the model.

Calibrating the model to available data, the authors find on impact a 25.7 cent increase in investment spending and a 3.5 cent increase in output for every dollar of tax stimulus. Cumulatively, investment increases by 4.6 cents and output increases by 7.2 cents. These multipliers are relatively large, but strongest among "startups" and weaker among mature firms. Startups refer to the newer firms in the model hit with positive "entry" shocks and mature firms are existing firms that have not been hit by "exit" shocks. The authors offer the following explanation – newer, constrained firms invest close to the entirety of the tax cut, putting upward pressure on the interest rate, which crowds out larger, unconstrained firms.

One conference participant asked if the presenter is including tax credits and depreciation allowances or other tools under the umbrella of "tax cuts" in the model. The presenter noted that yes, they are abstracting away from specific policy tools and simply considering any lump-sum instrument. One conference participant inquired about the importance of the structure and timing of the exit shocks in affecting the size of the multiplier.

The presenter noted that due to the way the events are ordered, the tax cut may keep unproductive firms from exiting that would have exited otherwise, but it also might incentivize new firms to enter the market. Conference participants had several questions about the timing assumptions of the author's model, particularly the timing of the firm's productivity shock after the firm's investment decision in each period. The presenter stressed that the particular timing of the model is not too important to the analysis, and that firm growth dynamics is mostly determined by levels of financial frictions. ◊

Optimal Debt Maturity and Firm Investment

Immo Schott and Joachim Jungherr

Default rates, bond spreads, leverage, and debt maturity all increase during recessions, while the term structure, or the difference between long-term and short-term bond spreads, decreases. The authors set out to prove that a single mechanism – cyclical debt dilution - is what drives these observed correlations with GDP.

The presenter contends that this paper contributes to the emerging literature on long-term debt by offering the first firm financing model with both endogenous debt maturity choice and aggregate fluctuations. The inclusion of long-term debt is motivated empirically by the fact that the average of maturity of newly issued debt in the US is about 5-6 years. This flies in the face of the standard model in the literature, which relies on the inclusion of only one-period debt contracts, with the standard result being that of a constrained-efficient equilibrium. The authors show that the inclusion of long-term debt contracts and endogenous maturity choice results in a constrained-inefficient equilibrium, in which optimal maturity choice is time-inconsistent and future maturity is too high (i.e., firms choose too much long-term debt and too little investment).

In their model, firms face two tradeoffs, one between equity and debt and one between short-term and long-term debt. This second trade-off is implicitly a trade-off between the transaction costs a firm faces when issuing new debt and the cost of debt dilution. Debt dilution refers to when the firm does not internalize the full costs of its actions on the value of existing debt. If the firm is disregarding the costs of default, the firm is going to lever up more than it normally would. The paper shows that during recessions, firms disregard a larger fraction of the potential costs of default. The authors first use a two-period model to analytically derive the cyclical role that debt dilution plays in the bond market. These analytical results are used to give context to the numerical results from their fully dynamic model.

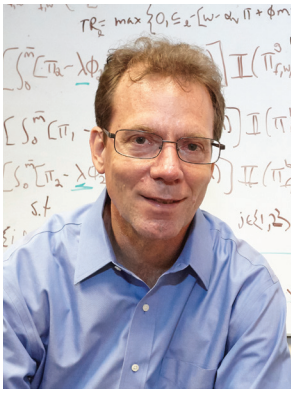
Models including both maturity choice are generally difficult to solve. This paper overcomes computational hurdles by expressing equilibrium bond prices as a function of choice variables and future firm actions. This allows for equilibrium bond prices to be computed in a single step.

The authors conduct a few policy experiments utilizing their dynamic model. In one of them, the use of long-term debt contracts is banned. The authors contend that this reduction of a firm's choice set will make firms better off through the reduction of credit spreads and an increase in investment.

One conference attendee asked about the role of seniority in the model. If one's debt is more senior, then the effect of debt dilution is, of course, weaker. The presenter responded by saying there is not heterogenous seniority in the model, but that mechanism can be included in an extension. Another attendee asked about why a firm would want to issue a mixed bag of maturities in the first place, in addition to the tradeoff between the two sets of costs. The presenter responded by saying a firm may want to match the term structure of their obligations to the term structure of their investments. ◊

Old, frail and uninsured: Accounting for puzzles in the U.S. long-term care insurance market

R. Anton Braun, Karen A. Kopecky and Tatyana Koreshkova



About half of U.S. 50 year-olds will experience a nursing home stay (NH) before they die and approximately one third will experience a stay over 90 days. A sizable fraction will incur out-of-pocket expenses greater than $200,000, which corresponds to an average duration of 3 years. These long-stays are important because social insurance like Medicare, which is universal, is only available for short-stays. Social insurance for long-stays in a NH (Medicaid) is means-tested and only available to those with assets below $2000. Despite the extent of NH risk and the limited coverage of public insurance, the long-term care insurance (LTCI) market in the U.S is small. Less than 10% of retirees over 62 have private LTCI, and private insurance payments only account for 4% of aggregate NH expenditures. This market also exhibits a number of puzzling features. Specifically, ownership of LTCI is increasing in wealth and decreasing in frailty, and rejection rates based on LTCI guidelines are high — with the authors estimating that at least 36% of 55-66 year olds would be rejected by insurers

due to frailty. Contracts only cover 30-60% of expenses and are not actuarially fair, and LTCI owners are less likely to enter a NH than non-holders.

The authors propose an optimal contracting equilibrium model of the LTCI market, to resemble contracts at the qualitative level. It features supply-side frictions attributed to both private information about NH risk (adverse selection) and market power by the insurer who faces overhead costs. The demand-side frictions are generated by the presence of a public means-tested program (Medicaid) that crowds out demand for private LTCI. The model is calibrated to match cross-sectional variation in frailty, wealth, survival risk, NH entry risk, and LTCI take-up rates using data from the Health and Retirement Survey (HRS). This allows the authors to predict the optimal contract as wealth and frailty vary, as well as determine the role of each friction on individuals of different levels of wealth.

Dr. Braun introduced a simplified one-period version of the baseline model that nests the standard adverse selection setup as a special case. There is a continuum of individuals who have private information about two risk exposures (good from the perspective of the insurer or bad). Agents receive an endowment and then purchase LTCI for a premium and an indemnity. The NH event is realized next, and individuals who experienced it receive a means-tested transfer from Medicaid. Individuals maximize expected utility. The firm has two distinct features in this model: there is a single insurer and it faces proportionate overhead claims processing costs (administrative costs). The difference between this market and regular insurance is that there is a big gap between purchase and claims. Therefore, insurers need to have higher resources available to account for the fact that conditions may change dramatically during this time.

Most of the discussion up to this point centered on clarifying questions about the set-up of the model and definition of concepts. For example, a participant asked about demographic/geographic predictors of entering a NH. Dr. Braun answered that the model includes wealth and frailty, but not geographic characteristics. Another question regarded commitment — to which Dr. Braun pointed out that this is a static model because there are not enough periods to address long-term dynamics.

Under certain values of the parameters (no administrative costs, no Medicaid) the model yields the predictions from Stiglitz (1977) — namely, full insurance for high-risk types, separating equilibria and downward distortion for good risk. The introduction of administrative costs can result in equilibria where both types are offered less than full insurance as well as equilibria where neither type is offered a positive contract. On the other hand, the introduction of Medicaid also generates this result because it acts as a competitor that offers free insurance, increasing utility in the absence of private insurance. An important assumption for this result is also that endowments are uncertain. The theoretical results are therefore independent of the type of friction introduced — both demand and supply-side frictions can each, independently, produce partial coverage or rejections.

Dr. Braun proceeded to introduce different risk groups to the simple model, addressing one of the comments previously discussed. A risk group is a group of individuals that look identical from the perspective of the insurer. In this setting, there is cross-variation in wealth and frailty and the insurer observes only noisy indicators of the true NH risk exposure. Under the assumption of high dispersion and the fact that conditional on surviving, poorer and frail individuals have higher probability of entry to a NH, the insurer will offer distinct contracts to each risk group and screen out of frail risk groups.

These ideas are generalized into a more complex quantitative model that considers an endowment economy with two periods, where period 2 is divided into two subperiods. The economy consists of three kinds of actors: a continuum of individuals, a monopolist provider of private LTCI, and a government. Individuals are young in period 1, old in the first subperiod of period 2 and very old in the second subperiod. All individuals become old. At the beginning of the first subperiod, the insurer issues policies and pays out profits to old individuals as dividends. Between the first and second subperiods, a survival shock occurs and some old die. At the beginning of the second subperiod, the very old face the risk of experiencing a NH event. The government taxes individuals and uses tax revenue to finance a welfare program for retirees and a Medicaid program for NH residents.

The assumption of two periods is important because Medicaid distorts savings decisions. If an individual faces low earnings when young, then it may be reasonable to reduce savings and later rely on Medicaid for NH expenses. At this point, a participant asked whether if frailty interacts with consumption, it will also affect savings. Dr. Braun answered that the idea is that in the first period, the individual observes frailty and this is a noisy indicator of NH risk. A frail and poor individual will then decide not to save. A follow-up question focused on the effect of bad health on marginal utility of consumption — to which Dr. Braun answered he was not sure because they had not done welfare analysis.

Dr. Braun concluded his presentation by discussing the calibration exercise, where a key insight was that LTCI take-up rates increase and wealth and decline in frailty. They find that low take-up rates of private LTCI and contracts that provide only partial coverage of NH costs are to be expected when overhead costs and the crowding-out effects of Medicaid are recognized. Insurers optimally respond to these frictions by

rejecting individuals who have poor health or low income via medical underwriting, and by both increasing the price and reducing the comprehensiveness of insurance offered. Unlike the theoretical model, both supply and demand-side frictions are needed to account for the small size of the LTCI market. ◊

Firm Entry and Exit and Aggregate Growth

Sewon Hur, Jose Asturias, Timothy J. Kehoe and Kim J. Ruhl

The authors analyze the relationship between aggregate productivity growth and the entry and exit of firms. Firm entry and exit contribute to economic growth since inefficient businesses in the market exit, and efficient potential entrants can enter the economy. To investigate further, they decompose aggregate productivity growth into two parts using the method in Foster et al.(2001). One part is the contribution of continuing firms, and the other is that of new entrants. From previous literature, the contribution of firm entry and exit on economic growth differs across countries. Using data from Chile and Korea, they find empirically that the entry and exit of companies are more significant during the period of faster output growth than that of slower output growth. Based on Hopenhayn (1992), the authors set a dynamic general equilibrium model to reflect firm entry and exit and find equilibrium. They calibrate the model to U.S plant-level data and simulate the effects of policy changes in three distorted economies.

The authors construct a model with three features. First, potential entrants draw their efficiency from a Pareto distribution, and efficiency improves each period as they arrive on the market. Second, both an exogenous process and spillover effects from other existing firms can make the efficiency of existing firms higher. Third, the model allows for both endogenous and exogenous exit, even though endogenous exit plays a role in economic growth. In their model, households choose consumption and bond holdings to maximize lifetime utility and pay a fixed entry cost for new entrants to receive dividends in the future. After observing drawn efficiencies, potential entrants in the market decide whether to enter the market. Operating firms choose the amount of labor to maximize dividends after paying the continuation cost with wage costs subtracted from production. Both the entry cost and continuation cost consist of a homogeneous part and a policy part. The barriers to technology adoption are reflected in the parameter of a Pareto distribution.

The authors show that the sequence of wages, outputs, consumptions, dividends, and entry-exit thresholds grow at a constant rate as time passes on a balanced growth path. They consider three types of reforms which make the old balanced growth path move to the new one through both direct and indirect effects. Before simulating policy changes, the authors calibrate the model to match key features of the U.S. economy. They assume that there is no distortion in the U.S. economy and create three distorted economies with the higher entry cost, fixed continuation cost, and barriers to technology adoption, respectively, so that output on the balanced growth path is 15 percent lower than in the non-distorted economy. For simulation, they eliminate the distortion in each distorted economy and analyze how the economy moves to the new balanced growth path. First, when they decrease entry cost, more potential entrants enter the economy permanently, since a firm becomes more valuable. Then more entries demand more labor. Due to higher labor demand, equilibrium wage increases, which makes dividends lower. As a result, some low-efficiency firms decide to stop operating. Higher labor demand also increases the threshold efficiency level, which is the minimum efficiency level to enter the market. Thus, this changes the composition of operating firms. These changes are strongest during the transition when aggregate productivity grows the fastest. Second, lowering barriers to technology adoption has similar effects with reducing entry cost, although the mass of potential entrants increases less than the case of lower entry cost. These are why firm entry and exit is more crucial during periods of faster output growth. Unlike the reforms in the entry cost and barrier to technology adoption, lowering continuation cost decreases aggregate productivity. That is because lower continuation cost allows low-efficiency firms to stay in the market, and less efficient firms can enter the economy in favor of higher dividends. The authors find that their model matches the data successfully. During periods of fast growth, entrants in the model are 14 percent more productive than the average firm in the previous period, compared to 17 percent more productive in the data. On the other hand, during periods of slow growth, new firms in the market are 7 percent more productive than the average firm, compared to 2 percent in the data. Also, policy changes in Chile and Korea during the periods of fast growth are consistent with lowering barriers to technology adoption and entry costs.

Audience members were concerned that the authors do not consider demography, since it can affect firm entry and exit behavior. The second author replied that the mechanism is the same, even though the extent of contribution might differ depending on demography. One audience member questioned whether the distribution on which potential entrants draw their efficiencies was reflective of reality. Another audience member was concerned that the inclusion of foreign firms might lead to biased estimation, since foreign companies are sometimes more reluctant to enter and exit the market. Finally, one audience

member wondered whether spillover effects matter for the results. The second author replied that they matter in both model and the data. ◊

The End of the American Dream? Inequality and Segregation in U. S. Cities

Alessandra Fogli and Veronica Guerrieri

Over the last 40 years, the U.S. has experienced a large increase in inequality. During this time period, there has also been a substantial increase in residential segregation by income and education. In "The End of the American Dream," the authors explore the empirical and theoretical relationships between inequality and residential segregation. The empirical analysis constructs local measures of inequality and segregation and shows a strong correlation between the two across time and space. To further explore this relationship, a GE model is employed in which inequality and segregation are both endogenous and reinforce each other.

The analysis begins with the construction of measures of inequality and residential segregation at the MSA level. Inequality is measured using a Gini coefficient of relative incomes for each MSA. The measure of segregation is constructed by dividing the sample into two mutually exclusive groups (ex. being/not being in the lowest 10th percentile of the local income distribution). The segregation measure is the evenness of these two groups across census tracts within a given MSA. By this measure, if members of each group are clustered into census tracts (as opposed to evenly distributed across tracts), then the MSA is said to be more segregated. Income data for individuals in each census tract comes from the 1970-2010 censuses. The NLSY79 provides information on intergenerational mobility and the Stanford Education Data Archive provides information on average test scores within each school district. The results show a strong correlation between inequality and residential segregation across time and space. In addition, more segregated areas appear to have a larger educational gap between the poor and rich and in these areas, intergenerational mobility is weaker.

To further investigate this relationship, the authors use a GE model with overlapping generations of agents: parents and children. Parents earn some wage and choose consumption, residential neighborhood, and whether to send their child to college. Their utility depends on consumption and their child's future earnings. Children have ability drawn from some distribution, and their future wages depend on ability, whether they attend college, and neighborhood spillover effects. These spillover effects can be attributed to public school quality, peer effects, learning from neighbors' experiences, or other various mechanisms. By assuming that future wages are increasing in ability, college attendance, and neighborhood spillover — and by making other simplifying assumptions — the model allows for the possibility that inequality and segregation amplify one another leading to a poverty reinforcing mechanism. They posit that this mechanism may be partially responsible for the simultaneous rise in inequality and segregation over the last 40 years. Several numerical exercises are performed with results that are consistent with this idea.

During the discussion, there was much interest in what the model would predict in response to particular policy interventions such as housing or education subsidies. While the results of such policy experiments were not available at the time, the model could prove to be a useful tool in predicting the effects of these interventions. It was also mentioned that it may be interesting to identify the particular mechanisms through which neighborhood spillover effects operate. For example, could more wealth lead to better quality of schools which could in turn increase children's return or preferences for education? Or is it truly a neighborhood interaction effect where exposure to peers with a variety of socio-economic statuses leads to better learning about the returns to education. There was interest in whether the effects of segregation could be different based on whether the parents were working versus retired. A question was asked as to why the data might get "cut" in a specific way in order to define the measure of segregation. For example, cutting the data at the lowest 10th percentile of the income distribution versus the highest 10th percentile of the income distribution may provide different results and suggest different mechanisms through which the relationship between inequality and segregation is operating. ◊

The Pricing of Sovereign Risk Under Costly Information

Grace Weishi Gu and Zach Stangebye

Fund managers do not have resources to pay attention to all the financial assets they are investing in at the same time. Instead they set up flags for indicators about the underlying conditions of the financial asset. Once the flag is triggered then the manager pays intense attention to the underlying conditions, for instance a particular bond in sovereign bond markets. This raises the idea that the investor attention to the underlying conditions of assets may not be constant over

time. Gu and Stangebye aim to capture this observation and incorporates it into a standard sovereign default model. They measure the attention using Google's search index (SVI). Since it is not a perfect measure of investor attention, the authors look at the extreme returns in country spreads and find that they are highly correlated with Google search index.

The authors explore the role of investors' attention in the pricing of sovereign debt. Hence, they incorporate observed and unobserved information as well as investors' rational inattention into a standard sovereign default model. The model generates state-dependent allocation of investor attention, which interacts with sovereign debt pricing. When debt levels are low and output is high, investors acquire less information to save on costs. For high debt levels and low output states, they pay to acquire information on unobservables. The default is high in crisis times, but risk premium is low due to increased information acquisition. This implies that in bad times, default risk comprises a larger fraction of the spread on the short-term sovereign bond. This further implies that a standard sovereign bond model without costly information acquisition understates the default risk.

The model also explains time-varying volatility with rational inattention. In normal times, investors pay little attention to unobservables, hence they are assumed to be at their mean, bond yields exhibit lower volatility. During crisis times, investors acquire more information, hence unobservables are priced better. Bond yields respond to realizations of unobservables which increase the volatility. The authors calculate a model-free metric of the time varying volatility called Crisis Volatility Ratio (CVR). The model without costly information acquisition has a CVR which is a lot lower (1.68) than the CVR generated by data (3.67). Incorporation rational inattention with costly information acquisition generates 29% increase in the CVR (2.12).

A third finding of the model is the non-monotonicity in sovereign welfare as a function of information costs which can be considered as a measure of transparency as well. When information is infinitely costly, risk premium increase due to lower information which makes borrowing more expensive for the sovereign. When the costs are very low, price volatility is high, hence risk-averse sovereign does not prefer. Therefore, welfare is maximized in a middle level of transparency.

One of the audience members commented that the financial analysts are supposed to closely watch the assets they are investing. Gu answered that, in practice, they are not watching all countries closely all the time, instead they choose a group of sovereign bonds to pay intense attention. ◊

The Disability Option: Labor Market Dynamics with Macroeconomic and Health Risks

David Wiczer and Amanda Michaud

The number of U.S. Social Security Disability Insurance (SSDI) beneficiaries has risen consistently for the past 30 years. However, this long-term rise seems not to be explained by simple observable characteristics of the labor force, such as age/gender structures or awards per application. Several comments by participants regarding specific definitions on eligibility to SSDI and the design of SSDI were addressed up to this point. An important clarification was that since 1984, when the program was dramatically changed, there have only been minor tweaks in the rules. Therefore, for practical purposes, this can be treated as a stable policy regime since this time.

The main question the authors try to answer is what drives aggregate SSDI trends. They develop a quantitative framework to understand SSDI enrollment dynamics that includes health, economic risks, their correlation, and a realistic program design that resembles SSDI. The key insight of the model is not only how economic or demographic forces affect SSDI claims, but also how their interactions define individual choices. These forces are intertwined in important ways. First, the response of each individual's SSDI application decision to changing economic conditions depends on their demographics. When facing the same economic prospects, we would expect a greater response from those already on the margin of participation: older workers approaching poor health. Second, an individual's demographics affect his or her exposure to economic shocks. These marginal workers, those older and in poor health, are disproportionably represented in declining sectors, such as manufacturing. Third, institutional rules regarding SSDI claims are determined conditional on vocational factors: worker's demographics and the economic shocks, as well as health outcomes.

To capture these ideas, the authors introduced macroeconomic risks — both cyclical and structural — to a Low and Pistaferri (2015 AER)-type model. Their model considers the following institutional features: eligibility is based on 5-month unemployment; acceptance probability on Disability Insurance (DI) is based on health and vocational condition of the applicant — with the latter being a function of age and macroeconomic conditions. Benefits from insurance depend upon past earnings, and this is an absorbing state. Individuals in this model face three types of economic shocks that may encourage applications to DI: idiosyncratic persistent

wage shocks, technological or long run change in lifetime wages and cyclical unemployment risk. Aging makes SSDI more attractive to individuals. Health deteriorates stochastically over time, implying a higher disutility to work, lower wages and higher SSDI acceptance probability. All of these elements of the model affect individual's application decisions.

The model, therefore, links agents deciding upon SSDI applications when facing correlated economic and health risks as they age and a Government that takes this into account. The quantitative framework serves as a measuring devise to make a positive statement about how much aggregate enrollment depends on the composition of the work force and individual behavior in response to shocks. The model features overlapping generations of agents that spend a portion of their lives with the option of participating in labor markets and a portion of their lives in retirement. Agents differ in the extent of their disability, wages, age, and labor market history. At the beginning of their career, agents choose a lifetime occupation. Occupations affect future wage and disability outcomes. Throughout their career, agents choose whether to participate in the labor market, whether to apply for disability payments, and how much of their income to save.

The model was calibrated using external measures on occupation specific health risks, SSDI health-based acceptance probabilities, age distribution, and occupation size and evolution. Within the model, wage trends, occupation-cycle-specific finding and separation rates, size of disability insurance, and acceptance probabilities infer based on outcomes were matched. PSID was used to associate workers with a "life-time occupation" and occupations were defined by O*NET principal components. These are the tasks individuals perform within that occupation: 1 physical demanding task and 2 non-physical tasks.

Dr. Wiczer presented a set of preliminary results. The main finding is that the elasticity of SSDI with respect to long-term earnings decline is 9%, and with respect to unemployment risk is 0.1%. This means that the former strongly influences insurance uptake, while the later, related to cyclical fluctuations, have a moderate impact on SSDI. This result may be explained by the fact that recessions are short and, in the model, disability insurance is an absorbing state. A participant suggested that an alternative explanation is that individuals use unemployment insurance for consumption smoothing. Another asked if large changes in unemployment duration are observed, because it seems as if unemployment duration, rather than risk, leads to this result. Dr. Wiczer acknowledged that there is not a clean distinction in the model and that separation rates are uniform for every individual. Duration dependence is not built into the model, because there is not much information in the CPS, although it seems important.

A participant suggested that this result looked like permanent income effects and asked whether it was necessary to set the problem in the quantitative framework suggested by the authors. Dr. Wiczer replied that the setting suggested by the participant is a special case of their model, where all risks are homogenized and only changes in earnings are included. While the authors may have built in more elements than needed, they argue that this is useful given that the framework is used as a measuring devise. This allows them to decompose how different forces drive the trend and understand that there are meaningful interactions between these forces, which cannot be treated as linear contributors to the overall trend.

Instead, the authors do a Shapely-Owen Decomposition in which they first turn off the long term earnings decline and look at the associated change in disability insurance. Then they turn off health risks and look at additional changes in disability insurance, and subsequently turn off changes in age and demographics. Finally, they perturb all of these different orders to get average effects from earnings changes and from health changes. They find that earnings decline account for 22% of the rise and asymmetric health risks is approximately 32%. The rest is explained by aging, which means that older people have worse health outcomes and are more susceptible to long term earnings decline. The probability of acceptance is therefore higher given the characteristics of the institutional setting. In general, the model undershoots the rise, but it manages to capture 63% of the overall increase in SSDI. The model replicates the upward sloping age profile and these results allows them to establish that long-term trends are more important than cyclical. There is a strong elasticity of going into DI and long-term outcomes in occupation, but low with unemployment. Dr. Wiczer concluded his presentation by arguing that they managed to produce a calibrated laboratory for accounting, forecasting, and program design of SSDI. ◊

Sources of Inequality in Earnings Growth Over the Life Cycle

Serdar Ozkan, Fatih Karahan and Jae Song

The authors investigate the vast inequality that exists in lifetime earnings. A worker who is at the 90th percentile of the earnings distribution earns about four times more than a worker at the 10th percentile of the earnings distribution. A stirring figure shows that the lifetime earnings profile for workers at the top of the earnings distribution is very different from workers in the middle of the distribution or workers at the

bottom of the distribution. Inequality increases over time. By age 35, it is large. By age 45, it is even larger.

This growing inequality in earnings growth over the lifecycle is a major determinant of lifetime earnings inequality. Eliminating the heterogeneity in growth would cut the inequality between workers at the 90th and 10th percentile in half. This paper asks what explains the vast heterogeneity in lifetime earnings growth. The authors consider three potential explanations that have been discussed in previous literature: the ability to accumulate human capital, the ability to climb the job ladder, and luck.

The paper uses a rich administrative dataset: employer-employee matched data from the Social Security Administration (SSA). The data is yearly wage and salary income from W-2 forms, from years 1978 to 2013. The focus is male cohorts born between 1951-1957, for whom the authors can analyze earnings from age 25 to 60. This rich data provides major advantages over survey data.

Using this data, the authors develop a job ladder model featuring worker heterogeneity in returns to experience, unemployment risk, job finding rate, contact rate, and firm distribution. It also allows for recalls for unemployed workers by their last employer, as seen in the data. Finally, there is also ex-post idiosyncratic risk.

The model is estimated by targeting percentiles of earnings growth. After it is estimated, the authors decompose lifetime earning inequality. Because the focus of the project is workers who are strongly attached to the labor market, workers are excluded if they are full-year unemployed either for more than one-fourth of their lifetime, or for two consecutive calendar years. Workers who are self-employed are also excluded. These restrictions result in a balanced panel of attached workers.

The first result is that the number of employers is negatively correlated with the percentile of the earnings distribution. Workers with more employers have lower earnings. The second result is that the top unemployed quartile accounts for 65-80% of aggregate unemployment.

Because these results imply an extensive discussion of mobility – both between employers as well as in and out of unemployment, the paper turns to discussing mobility. They find that high lifetime earners are more likely to be stayers – that is, stay with their current employer. There is much more pronounced heterogeneity in earnings growth between non-stayers relative to stayers. This is quite an intuitive result. Another major result is that older non-stayers, defined as age 45-55, experience negative earnings growth.

Because the data provided in the SSA data is at the yearly level, the mobility is not quite clear. On the other hand, the Survey of Income and Program Participation (SIPP), asks about employment status and switching behavior at the monthly level. The SIPP allows for computation of flow probabilities. Analysis of the SIPP finds that job-finding rates are higher at the top of the income distribution, while job to job switches are more common at the bottom of the distribution.

With these empirical facts in hand, the authors turn to building a model. The model features heterogeneity in workers and firm fixed effects, on the job search and employer competition, idiosyncratic shocks to worker productivity, and worker heterogeneity in unemployment risk and the job finding rate. Returns to experience are drawn from the Pareto distribution. Once in a match, the worker produces a single divisible good sold in a perfectly competitive market. In every period, a match terminates exogenously with some probability. Workers and firms bargain over the piece rate. Outside offers induce competition between firms, and the more productive takes the worker. The worker gets a share of the additional surplus.

This setup generates job to job changes with wage cuts, which were observed in the data, as well as endogenous wage increases on the job, on top of human capital accumulation. Recalls also help generate large wage cuts for stayers, which are very prevalent in the data. The estimation method is simulated method of moments, targeting percentiles of one-year earnings growth conditional on age separately for stayers and switchers, the fraction of stayers and switchers conditional on lifetime earnings income and age, and the lifecycle earnings profile by lifetime earnings groups.

The model captures the variation over the lifetime earnings and between stayers and switchers, but underestimates the dispersion for the top lifetime earnings group. It also overestimated the stayer probability for low- and high-income groups. It overestimated the income growth of employment to employment for low income groups, and underestimated the employment to employment switcher probability for low-income workers. It did, however, capture the fraction of employment to unemployment to employment switchers and their income growth quite well. It can capture the growth pattern over the lifetime earnings distribution well, but does less well at capturing average growth over the lifecycle. This is partially because the model is currently not allowing flow rates to vary by age.

The presentation brought about significant discussion. The first question as whether the differences in lifetime earnings were driven by different occupations. Unfortunately, the SSA data does not contain occupations. Similarly, there were questions about differences in labor supply – defined by hours worked, also not captured in the SSA data. One participant suggested reducing the window to age 50 instead of age 60 because of endogenous retirement. ◊

Saving and Dissaving with Hyperbolic Discounting

Dan Cao and Ivan Werning

The behavioral economics literature has long discussed the importance of quasi-hyperbolic discounting models, where preferences in each period over future consumption are not time consistent. In these models, also called beta-delta models, agents are present-biased but only modestly impatient between neighboring future periods. These models can therefore be seen as a game of multiple selves, each one deciding how much should be saved for tomorrow.

Krusell and Smith (2003) looked at Markov equilibria in this context and found a behavioral indeterminancy result. They found that there is a continuum of Markov equilibria whereby if the future-selves dissave, then the current-self also dissaves. This strategic complementarity implies that the model cannot offer robust predictions for given parameters and wealth levels.

The authors, find that the behavioral indeterminancy result found by Krusell and Smith can be ruled out. Because these equilibria are only defined in a local neighborhood around k-star, this construction cannot be extended globally. Instead, the strategic complementarity is dominated by the savings incentive given by a high interest rate. The construction is not part of any Markov equilibrium, at least for linear returns. This can also be extended to concave returns.

The model has preferences for utility that are increasing, concave, and continuously differentiable. Following other papers in this literature, it uses an isoelastic utility function. It is in finite time.

The first lemma is that the savings function is non-decreasing. This condition helps lead to the contagion principle. That is, suppose the interest rate is high enough to make savings sufficiently attractive. Then there is some threshold of wealth at which an agent will save if they are above and dissave if they are below. But the agent who is below this threshold and perhaps should be not saving actually has an incentive to save, to lead to an interval in which the agent expects their future self to save.

Put differently, if you know at some point you want to save, you will not ever dissave. As a result, any savings function that switches from strictly saving to weakly dissaving can be ruled out. This is a necessary condition for an equilibrium.

Holding wealth constant, there is a robust relationship between the time-consistent self-preferring saving to holding wealth constant. The current self prefers saving to holding assets constant so that the past-self also does because beta is less than or equal to one. As a result, the best response is for future selves to keep wealth constant.

Additionally, for rich agents, a long spell of dissaving is costly, given high interest rates. They prefer holding wealth constant. Because savings must occur at the top, given high interest rates, and there is an incentive to reach a threshold where the future self wants to save as well, for sufficiently high interest rates, the agent must save at all wealth levels.

The last result of the presentation was a characterization of this result in continuous time, as found in Cao and Werning (2016). The presenter concluded with discussing this intuitive result, and explaining its potential applications for other time-inconsistent settings such as political economy models of public debt.

The presentation was well-received. One audience member asked if the person saving or dissaving depended on the slope of lifetime income. The response was that this model is all based on wealth, and there is no income in the model. ◊

Quality Hours

Christine Braun, Finn Kydland and Peter Rupert

What is the correct measure of the labor input? The standard measure employed in many literatures is aggregate hours: the total number of hours spent by all workers at work. This approach, though prevalent, does not account for the fact that people are heterogeneously productive. That is, an hour spent working by one person may not be comparable to an hour spent working by another. Since this notion of productivity possesses interesting secular and cyclical behaviors, using a wrong measure for the labor input may drastically affect results and impact policy prescriptions. In particular, long-run increases in the average years of education and experience or the cyclical feature wherein less productive workers lose their jobs in economic downturns can confound analysis when the standard hours worked measure is used.

The authors address these concerns by proposing an alternative measure, dubbed 'quality hours,' that aims to control for the above issues. They ask what, if any, are the secular and cyclical differences between the quality hour and the standard hour measures. Correspondingly, what are these differences when looking at the associated quality of the workforce? Finally,

because the above has implications on measured productivity, both labor productivity and TFP, the authors look at how these series are affected by using a better measure for the labor input. While their paper is not the first to propose this sort of quality-adjusted measure, it makes novel contributions in its approach to data. Their approach and utilization of the CPS Outgoing Rotation Group allows the weighting of hours by returns to education and experience conditional on observable, within group heterogeneity. Furthermore, their approach produces time-invariant weights which release monthly.

The adjustment they employ involves a Mincer-style regression that controls for education, experience, and various other observables. Using a Cobb-Douglas specification to inform the relationship between the inputs of production and the associated output, the weight that is calculated is a transformation of components of the above regression that are integrally linked to a worker's productivity. The resulting quality hour series is found to have a higher yearly growth rate and to be less volatile, consistent with the notion that the workforce has become more educated and experienced over time, and that those employed during economic downturns are relatively more productive. Correspondingly, the workforce is 30% more productive today than it was in 1979, and that this quality is counter-cyclical. Last, when backing out measures of productivity using the new series, the authors find that the productivity slowdown (starting roughly around 2003) is 21 percentage points greater (i.e., productivity has fallen more) than what is calculated using standard labor series. A conference participant noted that there might be a participation margin that is ignored by a direct Mincer-style regression. As a result, the empirical approach might need to employ a Heckman correction to avoid the possibility of inconsistent cardinal rankings when constructing the weights. ◊

Laboratory for Aggregate Economics and Finance

Finn Kydland
Director

Peter Rupert
Associate Director

Laurie Preston
Business Manager

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Abel Gustafson
Editor

Eddie Peralta
UCSB Artworks
Newsletter Layout and Design

2112 North Hall
University of California, Santa Barbara
Santa Barbara, CA 93106-9215 U.S.A.
Phone: (805) 893-2258
Fax: (805) 893-8830
Email: Laurie.Preston@ucsb.edu
www.laef.ucsb.edu

To update your mailing address for future issues of LAEF, please send an email with your name and address to Laurie.Preston@ucsb.edu

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Laboratory for Aggregate Economics and Finance
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Santa Barbara, CA 93106-9215 U.S.A.

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