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FROM THE LAB

UC Santa Barbara | Laboratory for Aggregate Economics and Finance

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UC Santa Barbara
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Director's Message

Finn Kydland

This issue of From the Lab contains summaries of two related LAEF conferences, "OTC Markets and Securities," whose academic organizers were Bill Gavin, Federal Reserve Bank of St. Louis, and Batchimeg Sambalaibat, Indiana University, and "What We Know About Information in Financial Markets," organized by Zach Bethune and Eric Young, both at University of Virginia.

The daily volume of trade in the United States in various financial assets (equity, fixed income, currency, interest rate products, derivatives, securitized products etc.) today is around $4 trillion. Of this, $3.5 trillion (or about 90%) trade over-the-counter and the rest on centralized exchanges. Thus, the main way financial markets are organized is over-the-counter. A typical over-the-counter market displays the following patterns:

1. instead of a single price that clears the market, the terms of trade are specific to each transaction,
2. participants do not have public information on who is trading with whom at what prices,
3. most transactions involve broker-dealer institutions as intermediaries,
4. participants (both client and intermediary institutions) form a complex network of trading relationships with each other, and
5. over-the-counter transactions are mired with contractual and other frictions (counterparty risk, adverse selection, enforcement, reputation, search frictions, and so on).

The "OTC Markets and Securities" conference facilitated discussion and featured research that sheds light on why markets and assets are organized and designed the way they are, whether there are inefficiencies, and how we can improve them. Questions explored included: Why certain assets trade in decentralized vs. centralized markets? Why some trade in opaque vs. transparent markets? What do networks look like in the data and how do trading relationships form, and what is the optimal network structure in mitigating frictions and contagion? What are macroeconomic and asset pricing implications of these institutional and microstructure frictions?

"What We Know About Information in Financial Markets" took on a specific focus in understanding the second trait above about financial markets: that these markets are characterized by incomplete and dispersed information. Papers addressed questions including how a financial market's structure (e.g. the extent of search frictions or degree of connectedness of the trading network) impacts the effects of incomplete information, if trading costs can amplify informational efficiency, and how dispersed or heterogeneous beliefs impact the volatility of asset prices. In many of the environments studied, frictions can either amplify or mitigate information problems, leading to interesting welfare and policy implications. For instance, on the question "should financial transactions be taxed or subsidized?" several papers presented testable implications that could support either conclusion.

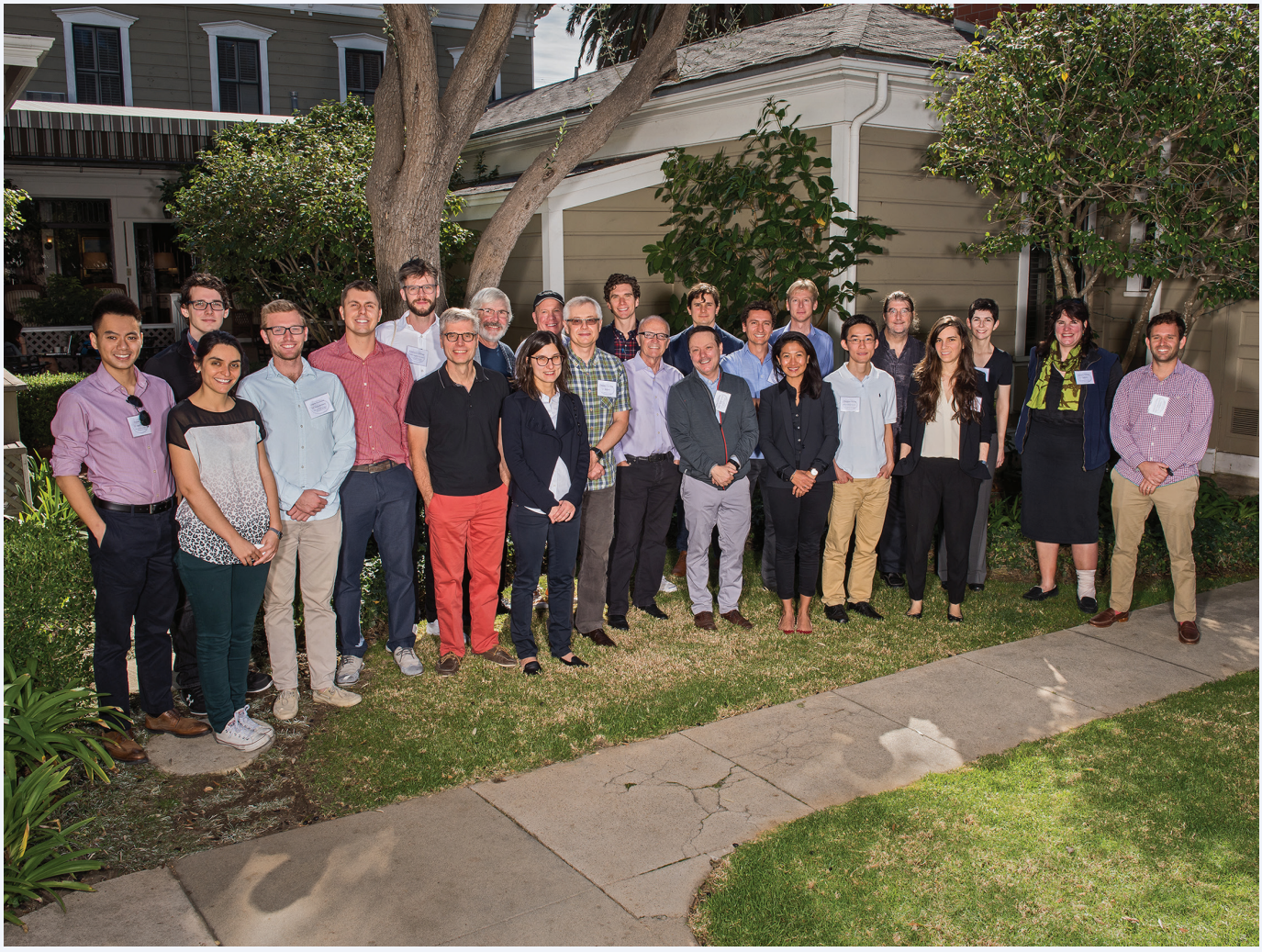
The goal of the research agenda addressed in both of these conferences is to help shape the policy discussion on how to improve the functioning of the financial sector and, ultimately, the allocation of capital across the economy.

OTC Markets and Securities Workshop

NOVEMBER 4-5, 2016

CONFERENCE PARTICIPANTS

Daniel Andrei – UC Los Angeles
Ana Babus – Federal Reserve Bank of Chicago
Travis Cyronek – UC Santa Barbara
Jason Donaldson – Washington University in St. Louis
Darrell Duffie – Stanford University
Phil Dybvig – Washington University in St. Louis
William Gavin – Federal Reserve Bank St. Louis
Vincent Glode – Wharton, University of Pennsylvania
Barney Hartman-Glaser – Anderson UC Los Angeles
Juliana Helo Sarmiento – UC Santa Barbara
Bernard Herskovic – UC Los Angeles
Burton Hollifield – Carnegie Mellon University
Finn Kydland – UC Santa Barbara
Yizhou (Andrew) Liu – UC Santa Barbara
Dmitry Livdan – UC Berkeley
Konstantin Milbradt – Northwestern University
Ed Nosal – Federal Reserve Bank of Chicago
E. Charlie Nusbaum – UC Santa Barbara
Christine Parlour - UC Berkeley
Peter Rupert – UC Santa Barbara
Batchimeg Sambalaibat – Indiana University
Lukas Schmid – Duke University
Or Shachar – Federal Reserve Bank of New York
Chaojun Wang – Stanford University
Pierre-Olivier Weill – UC Los Angeles



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

Strategic Fragmented Markets

Ana Babus and Cecilia Parlatore

Financial assets and debt instruments are traded in a variety of market structures. Large stocks, for example, are traded in highly centralized exchanges whereas debt is highly fragmented over the counter markets. Several papers have sought to address the cause of these varying degrees of market fragmentation by incorporating transaction costs, information asymmetries, and differing trading speeds in asset market models. In their paper, the authors expand this literature by building a model of strategic traders in which market fragmentation is tightly linked to the dispersion of investors' valuations of an asset and can arise in equilibrium in the absence of transaction costs.

In their model, the authors assume that there are both investors and dealers who trade a risky asset strategically. Investors, whose valuation of the asset consists of a common component and idiosyncratic component, first choose a dealer with whom to trade. Once these local markets are formed, dealers observe the common component of investors' valuations and trade with investors in their local market. If there is more than one active dealer (i.e., fragmented markets), they then trade strategically with one another in an inter-dealer market once all local market trades have been completed. Alternatively, if there is only one active dealer (i.e., centralized markets), all trades take place in the local market between investors and the dealer they selected. Using this framework, the authors solve for possible equilibrium market structures, and make welfare and liquidity comparisons between fragmented and centralized markets.

In solving the model, the authors show that a fragmented market structure can arise in equilibrium if there is sufficiently high correlation between investors' asset valuations. This results from two opposing effects: pricing and competition for liquidity. On one hand, trading in a centralized market decreases the price impact of any single investor and allows them to trade more. On the other hand, a large number of investors in the local market increases competition for the dealer's liquidity. As the correlation between investors' valuations increases, the latter effect begins to dominate. Consistent with empirical findings, these fragmented markets may be characterized by lower trading volume than centralized markets.

Additionally, in the BP framework there are some instances in which a fragmented market structure Pareto dominates a centralized market structure ex ante. In particular, they show that there is a threshold investor valuation correlation above which the competition for liquidity dominates the low price impact of investors in centralized markets and investor ex ante welfare is higher in fragmented markets. Furthermore, while the welfare of an active dealer in a centralized market is always greater than that in a fragmented market, dealers prefer fragmented markets when they are uncertain whether they will be active in the centralized market. As a result, the authors show that whenever a fragmented market structure is possible in equilibrium, it Pareto dominates a centralized market structure.

Several in the audience were enthusiastic about the paper and pointed out that the model presented several important implications. Still, a concern remained among other audience members regarding the authors' model, namely, that investors condition their strategies on their overall valuation of the asset rather than the idiosyncratic and common components separately. The audience members suggested that the model instead allow for investor strategies to depend on these variables separately to generalize the mechanism presented here. ◆

Can Decentralized Markets be More Efficient?

Vincent Glode and Christian Opp

Many assets are typically traded in decentralized markets. Despite their prevalence, they are commonly thought of as opaque and illiquid compared to centralized exchanges. Many commentators and policy makers have called for regulatory actions, which mostly amount to centralization of trade, often arguing that the recent financial crisis may have been exacerbated by this structure. But what is the optimal market structure for an asset? Can decentralized markets be more efficient? How can we explain the fact that some agents prefer to trade certain assets in decentralized conditions even when a centralized venue is available?

To understand the potential merits of decentralized markets, the authors develop a model that features the owner of an asset who can sell it to two prospective buyers. The seller realizes exogenous - but potentially uncertain - gains to trade. In a decentralized setting, the seller first contacts one buyer and quotes him a price. If the buyer rejects the offer, the seller searches for a second buyer and, provided he finds one, quotes him a potentially different price. This search for the second buyer may delay the realization of the trade surplus, which can be costly due to immediacy or liquidity concerns. When the market is centralized instead, no delay is necessary, since the seller posts a price and the two buyers simultaneously decide whether to accept or reject.

An important assumption of the model is that sellers, who do not possess private information, quote ultimatum prices to buyers. This allows the authors to guarantee a unique equilibrium (in most cases), as signaling concerns are avoided.

Moreover, this captures the observation that interactions in OTC markets are quick and there is little haggling. At this point, a conference participant pointed to a distinction between the equilibrium observation that there is little haggling and the ability to extract full rents, which are not necessarily the same. Professor Glode agreed and responded that in their model with a take it or leave it offer, the agent will not extract full rents because there is not enough information.

Asymmetric information and expertise acquisition are two very important features of the model. All agents are risk-neutral and value the asset as the sum of a common value and a private value. On one hand, the authors focus on two specific characterizations of the uncertainty in asset values: (i) uncertainty about the private value only and (ii) uncertainty about the common value only. In the former, no problem of adverse selection arises while in the latter this is accounted for. On the other hand, the authors assume information can be either exogenous to market structure or endogenous, in the sense that traders can choose how much information to acquire, at a cost, given the market structure. Under this set of assumptions, the authors analyze different scenarios that will allow them to identify the optimal market structure. To this end, they compare social efficiency in the two different market structures, decentralized and centralized, with differing uncertainties in asset value and exogenous or endogenous information. This allows them to identify specific situations for which decentralized trading socially dominates centralized trading, as well as situations for which the opposite is true.

The theoretical implications of the model are that since decentralized trading involves costly delays due to search frictions, centralized trading is socially optimal when agents' expertise acquisition and trading strategies are unaffected by the market structure. However, since traders' strategies generally vary across structures, decentralized markets may be more efficient. First, screening behavior may be less aggressive and inefficient in decentralized markets where traders reach fewer counterparties. Second, when private information improves allocative efficiency, decentralized markets with predictable trading patterns may dominate as they encourage expertise acquisition. However, the opposite is true when expertise yields private information that only benefits a traders' ability to extract private rents and causes adverse selection.

Most of the discussion centered on clarifying questions about the set-up of the model, parameters and assumptions. For example, a participant asked about the introduction of risk-averse agents. The author replied that in this particular setting having one asset accounted for this, as the decision is either to buy it or not. Another asked whether the sequential protocol for the decentralized market could be conceived as a Coase conjecture, to which Professor Glode replied that many conditions are not satisfied and under this set of assumptions prices are not quoted to the same agent. Later, it was pointed out that the model abstracted from the conditions of setting a centralized/decentralized market. These depend on the probability of finding a second agent in the decentralized structure. The author agreed and confirmed that they assume that they are already in place, meaning that a regulator can choose from either of the two structures.

In another set of comments, a participant pointed that, qualitatively, the results depended on the shape of the distributions. Professor Glode agreed and stressed that what matters is the trade-off between higher prices and the probability of trade. Another comment referred to a specific presented result, which showed that a buyer acquired more information on decentralized markets than in a centralized structure. The commenter pointed that this incentive depended on the fact that such buyer knows the position on the sequential trade. The author agreed and mentioned that in OTC markets, given predictability of trading interactions, they are able to incentivize some traders to acquire information because they know they are very likely to end up with the asset. In line with this result, another participant asked if they have considered the possibility of randomizing between buyers and if this yielded similar results to the amount of information acquired in the centralized setting. Professor Glode answered that they haven't looked at that case; and he acknowledged that it is complicated, given that it is not clear how to model expectations for the second buyer. ◆

Relationship Trading in OTC Markets

Dmitry Livdan, Terry Hendershott, Dan Li and Norman Schuerhoff

In markets that are decentralized, networks can be very important for economic activity. More specifically, the trading networks of investors in over-the-counter (OTC) markets are important for prices and execution costs. Investors with a lot of dealers can expect worse prices as their dealers expect less repeat business. The added competition of having many dealers increases the speed with which transactions occur, and enhances their bargaining position. The authors explore this mechanism in a model that endogenously determines both the size of the investor's dealer network (her "Rolodex") and the trade prices. This model's predictions are then tested in a comparison with fairly unique data on trades of corporate bonds between investors and insurance companies from the National Association of Insurance Commissioners (NAIC).

Unlike directed search models, or even the search-and-matching literature at large, the model constructed in this paper focuses on repeat relations and endogenous network formation. These other frameworks do not allow for finite networks of dealers, and as such are not appropriate for handling the observed trading patterns in many OTC markets. The patterns of interest to the authors in this paper are detailed using the NAIC data mentioned above, which tracks each trade of long-term stocks and bonds made by insurance companies. Their data includes all corporate bond transactions from 2001 until mid-2014 that were made between insurance companies (the clients) and dealers.

The authors find that few insurers trade more than once at an annual frequency. It is also found that insurer trading volume (which is the number of bonds in a trade) and number of trades is highly correlated with insurer type (i.e., health, life, P&C), size, and quality. This is to say that there is a large heterogeneity in the needs of clients. As such, the endogenous positioning of these clients in a network of dealers can be revealing about the structure and functioning of OTC markets. Large insurers have larger networks and also receive better prices because of repeat business.

The model that the authors construct generates results about both Rolodex size and prices. Clients choose a network of dealers by making an important tradeoff. A larger network increases search intensity (it is more likely to run into a dealer that wants to sell), which lowers the bargaining cost because finding another dealer is relatively easy. On the other hand, it is costly to maintain a large network, and so clients who do not require many, or repeat, trading opportunities will favor smaller networks and receive worse prices. Dealers then "race" to contact a client who has them in their Rolodex. Once met, the client either sells or buys the bond and receives some spread. The authors also build in repeat business benefits by allowing the dealer that sold/bought the bond to be re-contacted to buy/sell it back.

The prices in all of these transactions are determined by Nash bargaining. Should a deal fall through in the bargaining process, the client never does business with that dealer again, but this dealer is replaced with an identical dealer. This provides incentives for dealers to work and compete for future clients, which is a novel addition to models of OTC markets.

Estimating the model yields promising results. A combination of maximum likelihood and minimum distance estimation generate parameter estimates that agree with the intuition about trading behaviors in OTC markets. Furthermore, they use the estimates to see how well the model fits the data. With regard to matching both the distribution of network sizes across insurers and the prices they face, the model seems to perform well. A participant raised a concern about the assumption that failed negotiations lead to the loss of business forever with that particular dealer. Is it sequentially rational to assume this? Dmitry Livdan explained that this assumption was made for simplicity, and that sequential rationality wasn't something they set out to model. ◆

Conflicted Relationships

Christine Parlour, Tamas Batyi and Uday Rajan

In many OTC markets, the boundaries between broker, dealer, and investment advisor functions are somewhat porous. When OTC securities are smaller issues or bespoke, broker-dealers can only be effective if they also make suggestions. Thus, the authors model the relationship between a client and a broker-dealer who provides financial advice by constructing a bespoke strategy for coping with future financial contingencies the client may face. One feature of the contractual environment in the model is moral hazard. Devising a strategy for a client is costly in terms of effort, as the broker-dealer has to first learn the preferences or the exact needs of the client. Great effort implies that it is more likely to identify the right strategy, but effort is privately costly to the broker-dealer. In the model, after a client has signed on with a broker-dealer, she may be faced with another contingency that requires another financial strategy to be developed. The first need may or may not have fully materialized, so that the outcome of the first strategy may be unknown to the client. The client has to decide whether to re-hire the same broker-dealer she had before (i.e., to develop a long-term relationship) or to switch to a new broker-dealer.

When faced with a new client, a broker-dealer has two motivations to invest high effort. First, knowledge about the client's preferences is long-lived, so high effort with a new client reduces the cost of effort in future interactions with the client. Second, high effort increases the likelihood of a successful strategy being devised, and in turn increases the likelihood that the client signs on to a repeated relationship. Because the contract between the broker-dealer and the client is potentially long-term, the fee charged by the broker-dealer depends on the length of the relationship with the client. In addition, it depends on the severity of the client's needs and on the size of the client relative to the broker-dealer's overall client portfolio. As the fee is directly built into the markup of the security the client purchases, a direct implication is that the price paid by a final customer in the OTC market is customized to the client, and depends on the relationship between the client and the broker-dealer. Therefore, an excessive markup observed on the price

may merely reflect the quality of advice provided to the client. This is in contrast to the usual explanation of high markups as being reflections of inefficiency in the market as a result of search costs or bounded rationality on the part of clients.

One discussant asked whether it is sequentially rational not to consider renegotiation. The author noted that they explored only contracting environment with no commitment and with full commitment, thus such issue is irrelevant. Another discussant commented that the model might not be so much about finance in that it studies a general contracting problem featuring relationship. The author noted that most of the motivating examples come from finance. Another question asked about the reason for the learning-by-doing in the model. The author answered that they wanted to have something to appeal to reality and to do comparative statics. A final question was raised by a discussant. He asked whether the idea of the model can be interpreted as the existence of conscience reduces the potential contracting difficulties. The reason he asked this question was that the model then could be worked out in single period. The author answered that it depends on the magnitude of willingness to give the principal more discretion. ◆

Efficient Contracting in Network Financial Markets

Darrel Duffie and Chaojun Wang

The authors investigate whether bilateral non-cooperative bargaining is sufficient to achieve efficiency in environments where agents bargain in OTC network markets over the terms and prices of contracts. Specifically, the authors propose a theory of bilateral bargaining over the terms and pricing of contracts that may be contingent on the contracts signed by other pairs of agents in the network. This is motivated by the debate over allowing qualified financial contracts to include ipso facto clauses (assign the right to terminate a contract in the event of insolvency and to liquidate collateral) which is unrestricted by bankruptcy law.

In the authors' model, each pair of directly connected firms bargains over contractual terms. The equilibrium contract prices reflect the relative distress costs of the two counterparties, allowing the debtor to efficiently internalize its counterparties' distress costs and assign contractual priority efficiency. If the creditor suffers greater distress from loss of default priority than does the swap counterparty, then - in the naturally selected equilibrium - the pricing of the swap contract will include a price concession that is sufficient to convince the swap counterparty to give up priority. In this case, the creditor would be willing to accept a lower interest rate in order to receive efficient seniority. Conversely, if the creditor is better equipped to suffer losses at the debtor's default than the swap counterparty, then in equilibrium the debtor will offer a high enough interest rate to the creditor to encourage the creditor to agree to loss of priority, and the debtor will receive a correspondingly higher upfront payment from the swap counterparty. The debtor's shareholders have no direct concern with seniority at the debtor's own default, and are therefore able to act as a conduit by which the creditor and the swap counterparty can indirectly compensate each other for priority assignment.

In order to isolate natural equilibria, the authors extend the notion of trembling-hand perfect equilibrium to the network setting. They show that equilibrium contract prices converge, as exogenous breakdown probabilities go to zero, to those associated with the unique axiomatic solution that satisfies two newly proposed axioms, "multilateral stability" and "bilateral optimality." Multilateral stability is satisfied if (for any given network bilateral bargaining problem), whenever one "freezes" the actions and payments among a subset of pairs of directly connected nodes and then applies the solution to the bargaining problem induced for the remaining sub-network, the solution of the sub-network bilateral bargaining problem coincides on the sub-network with that prescribed by the solution to the entire network problem. Bilateral optimality is satisfied if (for any given network bilateral bargaining problem), when any two directly connected nodes maximize the sum of their total payoff under the assumption that the remaining nodes will react according to the solution applied to their sub-network, the maximizing actions they would choose are consistent with the solution of the entire network bilateral bargaining problem.

The authors assume an absence of general network externalities and allow contracts to have unlimited cross-contract contingencies. Even in this "ideal" setting the analysis suggests that apparently reasonable changes to the proposed bargaining protocol can lead to additional equilibria that are not efficient.

One discussant asked that if there is no uncertainty, can we think of the model payment as expected value. The author listed a few examples in which this conjecture is not accurate. Other questions inquired as to why there is no three-party contract, why the model did not consider common knowledge, and why the model needs money payment. The general answer from the author is that this restricted environment is precisely what they want to tackle, and that it is already quite complicated. ◆

Risk Reallocation in OTC Derivatives Networks

Bernard Herskovic, Andrea Eisfeldt and Emil Siriwardane

The authors explore how the structure of the OTC derivatives trading network, the preferences and technologies of the participants, and the distribution of endowed exposures to the underlying risk factor jointly determine the observed patterns of trade, post-trade exposures, and prices. They use the CDS (credit default swap) market as an example, and combine detailed data from the Deposit Trust and Clearing Corporation (DTCC), covering almost all trades, with a model of the OTC trading network. In the model, the authors take the empirical network of bilateral connections as given. They then use empirical observations on trades, resulting net positions, and prices to estimate the preference and technology parameters of the model. The model is suitable for studying a general OTC derivatives market, but they focus on CDS in order to fix ideas and to bring the model to the DTCC data. Agents are endowed with heterogeneous amounts of a risky bond with exposure to default risk. To reallocate their exposure to default risk, and to earn trading profits, agents can enter into long or short positions in credit default swaps with any of their connected counterparties. Agents are averse to two types of risk. First, they dislike exposure to the default risk in the underlying asset. Second, they also find it costly to engage in large trades with any single counterparty.

In the model, a trading network defines which agent can trade with whom. When two agents can trade, they agree on a CDS contract so that one agent provides insurance to the other. Agents take prices as given, and choose how much to insure. Hence, the amount insured and the volume of CDS contracts trades is endogenous, and prices are determined in equilibrium. Perfect risk-sharing is not achieved because of the cost of trading of large amounts with any counterparty, namely, aversion to counterparty default risk. Furthermore, equilibrium prices reflect post-trade exposure in the underlying asset and therefore the model features price dispersion in equilibrium.

The authors allow for different values for the two costs of risk bearing across agents, and they use empirical moments to estimate them. Heterogeneity in risk aversion drives aggregate default risk allocation between agents, while differences in the aversion to counterparty default risk determines the flow of default risk between different counterparties and how much agents exploit price dispersion to make trading profits. Therefore, risk aversion is an important determinant of net positions, and aversion to counterparty risk is important to determine gross positions.

The data include two complementary subsets of the DTCC's database: transactions and positions. For both of them, the data contains full information on the counterparties in the trade, the pricing terms, and so forth. The data effectively covers the entire CDS market for U.S. firms. The data shows that the CDS trading network is static through time and sparse.

One discussant asked whether there is a bargaining representation as an outcome. The author noted that the model parameters included it. The author also addressed the observation that agents will not share risk equally because they face different counterparty risk. Other questions inquired about the reason for exclusion of collateral and asset. The author answered that they wanted to focus only on the CDS market in the current study. ◆

Volume, Liquidity and Volatility in OTC Markets Featuring Asset Heterogeneity

Konstantin Milbradt

During crises, some assets have very low trade volume while others trade with large bid-ask spreads. In light of these observations, the authors ask several questions. First, they seek to understand how the presence of competing assets affects asset prices and liquidity during periods of capital shortages. Moreover, the author asks whether there can be self-fulfilling equilibria wherein assets are liquid today because investors expect them to be liquid in the future. Lastly, they investigate how liquidity characteristics such as haircuts and Value-at-Risk (VaR) influence asset price and volatility.

The author builds a random search model in an over-the-counter (OTC) asset market in which ex-ante homogeneous investors trade heterogeneous assets. All trade is intermediated by dealers, investors face liquidity shocks, and the distribution of asset types evolves over time. Those investors who have received liquidity shocks (L-type) must pay asset-specific, per-period holding costs. As a result, L-type investors holding an asset have an incentive to sell the asset to empty handed H-type (non-shocked) investors. When there are not enough empty-handed buyers, L-types instead trade relatively costly assets for those with lower holding costs. The latter trading scheme lowers overall surplus and improves liquidity in the market.

When endogenous search costs are added, asset heterogeneity has implications for trade volume as well. Since search is costly, dealers are only willing to intermediate exchange for assets with sufficiently high gains from trade. As a result, aggregate liquidity decreases.

The author provides five applications of the model. In the first application, the cross-sectional asset distribution is made stationary, uniform, and holding costs are flat. Instead, a boundary condition induces heterogeneity by forcing the surpluses to zero when the bond matures. Thus, heterogeneity enters through differing times to mature. Here, trade volume for long maturity bonds is and asset swaps occur for bonds with short times to maturity

In another application, the author uses the model to study volatility effects. When an agent is hit by liquidity shock, she needs cash quickly and can borrow against the asset until she sells the asset. There will be a haircut on the current price of the bond. This haircut is a function of return volatility and proportional to the slope over the level of the pricing function. As a result, a negative feedback between the volatility and price of a bond. This feedback effect may also influence the volatility of match surpluses.

One of the participants pointed out that H-types are able to make a profit and wondered if this result holds if there are more H-types than the L-types. The author explained that if search is not costly then H-types receive no surplus in this case. Another audience member was unclear regarding what features of the market can be captured by this model due to its noncompetitive nature. The author answered that the model features dealers with bargaining power and therefore can be incorporated in models of dealer markets with monopolistic frictions. ◆

Why Does the CAPM Fail Most of the Time, but Holds on Announcement Days?

Daniel Andrei and Julien Cujean

The presentation starts with a "tale of two days," displaying the following phenomenon: testing CAPM empirically on a full sample of days produces a flat Security Market Line, while testing CAPM only on days that coincide with macroeconomic announcements produces a strong, textbook relationship between Beta and the average excess return. The authors explain this phenomenon through a noisy rational expectations model with public announcements and private information.

The authors' explanation for why CAPM fails most days differs from past explanations that focus on leverage constraints, inflation, or disagreement. In this paper, the Roll's critique, stating that the true market portfolio is unobservable, generates the flatness of the SML, and public announcements alleviates this flatness by changing the variance/covariance matrix of returns and generating what the authors call "a better CAPM relationship."

The authors construct a discrete-time economy based off of Spiegel (1998), adhering to the Roll's critique, in which all stocks pay dividends with a common factor structure. All agents live for only two periods. All dividends load on a common factor that is mean-reverting. Public signals regarding the common factor follow an announcement cycle that occurs every few periods, with signals consisting of new information plus full identification of the signal from the last period (which takes care of the infinite-regress problem). Private information percolates at every period.

Utilizing the law of total covariance, the presenter contends that there exist different information sets for the agent and the empiricist/econometrician. While CAPM holds for an average, fictitious agent whose beliefs define the market consensus, it does not hold for the empiricist, who holds unconditional CAPM beliefs that do not coincide with those of the investors unless investors are uninformed. The authors define the two main effects that distort the empiricist's view of the economy and produce the different information sets– the unobservable market portfolio, and the fact that the conditional expectation and conditional variance of the next period's return at the current period move together in between announcements.

The presenter followed with the main result – when Beta is greater than 1, the empiricist overestimates Beta, and when Beta is less than 1, the empiricist underestimates Beta. This produces the flat CAPM line. However, just before the announcement on announcement days, investors know public information is coming, and therefore require a higher risk premium to hold the asset before the announcement. Because a higher risk premium is required, the security market line is steeper. In addition, the variance/covariance matrix, which is changing over time, has a stronger factor structure on announcement days because more information is coming.

One conference attendee asked why the model needs private information at all. The presenter acknowledged that it is not necessary for the main arguments of this model, but it is necessary to extend the model to address trading volume and disagreement during announcement cycles.

One conference attendee noted that the mathematics of this paper is very similar to that of Dybvig and Ross (1985), and that several results from that paper should apply to this model as well. The presenter responded by saying he has not checked if that is true but agreed in that the two papers are "two sides of the same coin."

One conference attendee was surprised that the presenter's result was never articulated before, given the large literature addressing announcement effects on interest rates. Another conference attendee expressed suspicion over whether this model produced a CAPM equilibrium or just CAPM in name only. The presenter's choice of exponential utility does not produce CAPM in two-date settings. However, the paper itself uses quadratic utility, which does work in two-date settings. ◆

The Paradox of Pledgeability

Jason Roderick Donaldson, Denis Gromb and Giorgia Piacentino

The requirement of collateral mitigates enforcement problems between borrowers and lenders. It is obvious that collateral matters when agents are borrowing and lending in environments with low cash flow pledgeability – environments that lack strong property rights, regulatory supervision, or technology. However, empirically, we see an abundance of collateral in markets with high cash flow pledgeability as well. For example, the US interbank market has upwards of five trillion dollars pledged as collateral. Why is collateral so abundant in these markets? The authors sought to answer that question.

While there is a large finance literature on the role of collateral in mitigating enforcement problems between borrowers and lenders, the authors focus on the often-ignored second role of collateral – to mitigate enforcement problems between lenders. If contracts are non-exclusive, a lender demanding collateral can prevent their debt from becoming junior to any new debt the borrower takes on – under the possibility the borrower goes bankrupt.

The authors find that in high-pledgeability environments, borrowers rely more on collateral. This is the paradox the title refers too. The reasoning is such that because of high cash flow pledgeability, it is relatively easy to take on new debt. Fearing the possibility of being diluted, lenders will demand collateral to protect themselves, spurring a "collateral rat race" in which all debt is secure. Since there are costs to collateralizing sustained by the borrower, this creates a "collateral overhang," encumbering assets that would otherwise be invested.

To explore the interactions between nonexclusive contracts and pledgeability, the authors set up a three-period sequential model consisting of one penniless borrower and two lenders. At date 0, the borrower can borrow from creditor 0 to invest in project 0, which has a known and riskless payoff at date 2. At date 1, the payoff of project 1 (the second project) is revealed to be of high or low type and the borrower may additionally borrow from creditor 1 (the second creditor) to invest in it. All loans are take-it-or-leave it and are settled at date 2. The borrower reaps a profit at date 2 of the project payoff(s) less the fraction of the project(s) that is required to be pledged to the creditors. If the debt is unsecure, no collateralization costs are paid. If the debt is secure, the borrower must pay an additional fraction of the cash flow to "fence off" the project. This amount is reaped by no one and is effectively a dead weight loss.

The first-best outcome in the model is one in which all positive NP projects are undertaken – investing in project 0 with certainty and project 1 only when the high payoff is realized. This is achieved with certainty if all debt is written as exclusive contracts. The authors focus on the case when no exclusive contracts exist. The first-best is also obtained if pledgeability is sufficiently low. In this case, the borrower is too constrained to borrow from creditor 1 if the low payoff is realized for project 1, and therefore can borrow from creditor 1 only if the high payoff is realized. If pledgeability is sufficiently high, if the borrower borrows unsecured from creditor 0, the borrower will invest in project 1 even if the payoff is of low type. Therefore, creditor 0 will not lend unsecured to the borrower, spurring the "collateral rat race," which in some cases will lead to the "collateral overhang."

The conference attendees had a few questions about the model itself. One attendee asked if everything is observed by all agents, to which the presenter replied yes. Another conference attendee added that assuming non-observability in the 2nd stage (date 1) may make the results a lot cleaner than what the authors have at the moment. There was also much discussion about alternative contracting schemes such as contingent or short-term debt. ◆

What We Know About Information in Financial Markets

NOVEMBER 18-19, 2016

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

Decentralized Markets through Derivatives

Marzena Rostek

Classical economic theory often assumes that markets are centralized. In practice, many assets such as real estate, foreign exchange, loans, and stocks are traded in decentralized exchanges. The presentation of ``Decentralized Markets with Derivatives'' described a framework of decentralized markets and examined the welfare implications of such exchange. The results suggest that through price impact, risk affects traders' incentives in a fundamentally different way when compared to centralized trading and that decentralized markets may allow for higher total welfare.

Three main results were discussed: First, when markets become more decentralized, some agents will trade with fewer other traders and with fewer assets which may cause price impacts of traders to weakly increase. Additionally, any change in the market structure that lowers price impact in local exchanges will lower price impact in the all other exchanges (even those indirectly connected).

Second, because of the fact that agents can trade distinct components of the aggregate risk portfolio, decentralized markets can result in higher welfare. So, while more decentralized markets result in higher price impact, the change in the traders' risk exposure can still lead to increased utility. Implications include that total welfare can increase in response to breaking up an exchange. Welfare may decrease in response to financial innovation. Introduction of financial intermediaries results in an ambiguous effect on total welfare. These welfare responses with respect to market structure changes are best understood by the impact on aggregate risk and demand substitutability, which is endogenous in decentralized trading.

Through price impact (the subsequent price change resulting from the trading of an asset), risk affects traders' incentives in a fundamentally different way than with decentralized trading. The non-proportionality of incentives in risk means that identical assets do not act as perfect demand substitutes. Heterogeneous demand substitutability for the same asset across agents incentivizes specialization in the trading of different assets. This contrasts centralized markets where agents' demand substitutability always corresponds to the fundamental asset payoff substitutability. Unless agents' risk aversions are close, decentralized markets are welfare-maximizing.

Third, whether decentralized markets behave locally like centralized markets depends only on agents' participation in the exchanges. In equilibrium, a market structure with an arbitrary set of exchanges resembles a forest (disjoint union of trees). Intermediation plays an essential role in the welfare effects of decentralization.

The discussion contributes to a growing literature on decentralized markets. In contrast to previous work, the analysis is based on the use of hypergraphs to represent the market. The results provide comparative statics of equilibrium and welfare with respect to preferences, assets, and market structure for decentralized markets with arbitrary market structures, multiple assets, and any number of strategic agents. ◆

Adverse Selection, Search Frictions, and Liquidity in Financial Markets

Ali Shourideh, Ben Lester, Venky Venkateswaran and Ariel Zetlin-Jones

Common metrics used to assess liquidity in financial markets are bid-ask spreads. Specifically, the difference between the ask price of an asset and the bids made by prospective buyers, where higher spreads are associated with lower notions of liquidity. Theory has proposed two main mechanisms to generate and interpret these spreads: search frictions and asymmetric information. Search frictions reduce the frequency of trades and produce market power, which can lead to these differences in ask prices and bids. Asymmetric information about asset quality, on the other hand, can induce potential buyers to underbid "good" assets whose type they believe might be "poor." A body of empirical literature has emerged to detect the presence of each mechanism in order to inform policy on potential tools to improve liquidity in these markets. For example, should policies be implemented that tax/subsidize trades to address issues related to asymmetric information, or should policies be implemented to lessen search frictions?

Unfortunately, assessing the above problem is difficult without a unifying framework; that is, the answer to the above queries might change if both mechanisms are included. The authors address this issue by developing a tractable, dynamic framework with search frictions and market power, asymmetric information, and learning from market-wide trading activity. Accounting for both search frictions and asymmetric information yields novel predictions about bid-ask spreads. They show that asymmetric information, namely the adverse selection problem, widens the spreads and that faster trading (i.e., lower search frictions) reduces these spreads.

The model features two agents who trade a single asset: traders with private information about the asset's quality and dealers who learn about this quality from trading activity. Traders receive liquidity shocks and can either hold, or not hold, the asset. Search frictions are captured by stochastic

opportunities for bilateral meetings between traders and dealers wherein dealers make take-it-or-leave it offers for the asset. In the case that the dealer does not have the asset, the bid price is given by the price at which she buys. When the dealer does have the asset, the ask price is thus given by the price at which she sells. The authors note, at least for preliminary calibrations of the model, that the option to sell is lower in the high state, and that this implies (given fixed beliefs about asset type) smaller spreads. Further, spreads tend to increase over time because, with informationally small agents, learning is slow - which exacerbates issues of adverse selection.

A conference participant asked whether or not agents could meet more than once per period. Answering in the affirmative, the presenter also noted that he thinks it does not matter. Considering that this model utilizes a period-by-period learning process, it seems that agents should be able to learn within a period, and that ignoring this might be inappropriate. The presenter agreed, but noted that the results (though preliminary) would be unchanged as given if they added in the assumption of one meeting per period. ◆

Asset Supply and Private Information in Over-the-Counter Markets

Bruno Sultanum, Zachary Bethune and Nicholas Trachter

Because of the decentralized nature of OTC asset markets, trade occurs in a bilateral fashion through some protocol. Furthermore, such bilateral meetings in these markets are plagued by private information. The authors ask if private information is indeed quantitatively important from an aggregate welfare perspective. They also investigate simple policies that can be implemented to mitigate any inefficiencies. While much of the existing literature considers information frictions relating to common values of assets and take these valuations as exogenous, the authors emphasize information frictions relating to private valuations and allow the distribution of these valuations to evolve endogenously.

The authors employ a model that assumes that time is continuous and infinite, both investors and asset issuers are risk neutral, and trade is broken up into a primary market and a secondary market. In the primary market, issuers randomly receive the opportunity to create an asset at some cost and randomly contact an investor. In the secondary market, owners and non-owners of assets meet with some probability determined in part by the distribution of owners and non-owners to trade assets directly. To make the model quantitative, the authors calibrate model parameters using data on the municipal bond market provided by the Municipal Securities Rulemaking Board.

The calibrated model matches the data well in all respects except for the difference in average bond yields between the two markets. Moreover, the model predicts that private information decreases trade volume, asset supply, and total welfare by 78%, 21%, and 8%, respectively, relative to a complete information benchmark. There are two primary mechanisms at work. First, because private valuations are not common knowledge during pairwise meetings, not all ex-post efficient trades occur. Second, private information causes the value to investors of holding an asset in the secondary market to decrease, because asset sellers give up informational rents and potential buyers' value of waiting to buy assets increases. As a result, fewer assets are issued in the primary market. Together, these two mechanisms cause a greater degree of misallocation and fewer investors satisfy their needs.

To explore inefficiency mitigation policies, the authors extend the model to include a trading subsidy. In particular, a participation fee is imposed on issuers who wish to issue new assets and a subsidy is given to issuers who receive the opportunity to do so. The authors show that the optimal policy is to charge a participation fee of roughly 10% and a provide a subsidy of approximately 33% of expected asset issuance costs. Such a policy reduces the welfare cost of private information from 8% to roughly 1.3% relative to the complete information case.

Two primary concerns were raised. Several audience members were concerned that in this model, those with the median valuation of the asset act as middle men, whereas in the real world middlemen typically only hold assets for speculative reasons. Others suggested that the authors should add an additional benchmark wherein private information is maintained but search frictions are eliminated, particularly since the results of their model were so dramatic. The authors agreed that this additional exercise could prove illuminating and noted that they would look into it further. ◆

Incentive Constrained Risk Sharing, Segmentation, and Asset Pricing

Pierre-Olivier Weill, Bruno Biais and Johan Hombert

The authors analyze a one-period general equilibrium asset pricing model with cash-diversion. It studies how ex-post moral hazard, limiting the pledgeability of the payoff of tradeable assets, affects the completeness of the market, the pricing of tradeable assets, and their allocation across agents. They obtain new results concerning the asset pricing and allocation of tradeable assets.

First, they find that tradeable assets are priced below the corresponding replicating portfolio of Arrow securities. This does not generate arbitrage opportunities because the price

wedge reflects the shadow price of incentive compatibility constraints. In this context, equilibrium expected excess returns reflect two premia. One is the risk premium, which is positive if the return on the asset is large when the pricing kernel is low, but which does not reflect aggregate or individual consumption due to incentive compatibility constraints. The other is the divertibility premium, which is positive if the return on the asset is large when incentive-compatibility constraints bind. This divertibility premium is inverse U shaped with betas, in line with the empirical findings that the security market line is flat at top.

Second, they find that the market for tradeable assets is endogenously segmented, as different types of agents hold different types of assets in equilibrium. This is because the equilibrium asset allocation optimally mitigates default incentives. Namely, agents who have large liabilities in a particular state of the world find it optimal to hold assets with low payoff in that state. They show that endogenous segmentation leads relatively risk-tolerant agents to hold riskier assets, and creates co-movement among the prices of assets held by the same clientele of agents.

In the model equilibrium, the incentive compatibility constraints prevent relatively risk-tolerant agents from providing the first-best level of insurance to more risk-averse agents. The prices of real assets are equal to the value of their consumption flows, evaluated with the Arrow Debreu state prices, minus a "divertibility discount". The latter is the shadow price of the incentive constraint. They also show that incentive compatibility constraints have implications for asset holdings. The model predicts that to optimally mitigate incentive problems, agents should hold assets with low payoffs in the states against with they sell a large amount of Arrow securities. Thus, even if the cash diversion friction is constant across assets and agents, the market will be endogenously segmented: different agents will find it optimal to hold different types of assets in equilibrium.

One discussant asked what is the advantage of modeling in this way instead of standard collateral model. The authors noted that if modeling this way then there is no need to take a position in Arrow security. Another discussant asked are there gains from trade. The author answered that the gains come from differences in preference. One discussant asked that if we suppose identical agents, will the outcome be the same. The author confirms it saying that it is because of the nature of endowment economy. One question concerns the uniqueness of the model results. The author said that uniqueness result will follow in some cases, e.g. if there is an equilibrium allocation, then price will be unique. ◆

Social Interactions and the Performance of Mutual Funds

Julien Cujean

The author notes that the vast majority of mutual fund managers are unable to generate abnormal returns and a significant fraction even underperform passive benchmarks. The handful of managers who outperform seldom maintain their performance. Yet, ample evidence indicates that managers have strong informational advantages. The author proposes a mechanism that resolves this apparent contradiction. The central feature is that fund managers generate investment ideas through social interactions. In particular, fund managers exploit information through word-of-mouth communication and share profitable ideas. While managers exchange ideas in a decentralized manner, they trade in a centralized market. Equilibrium prices thus partially reflect the conversations of other managers and constitute another source of information. In this context, private conversations act as a learning channel that complements the price-learning channel.

The author introduces a network structure in the model. The population of managers is segmented into two different classes, Network A and Network B. They differ in the quality of information exchanged and the intensity of meetings. The author provides empirical support to this network structure by estimating the network parameters. This structure affects the main results in one respect: a significant minority of top performers would not exist without it. In the model, social interactions produce a rich heterogeneity of idea precisions across managers. This heterogeneity creates a zero-sum game whereby managers trade against each other. In the zero-sum game, a manager's skill is naturally defined as the distance between a manager's number of ideas and the cross-sectional average number of ideas. Social interactions thus produce a distribution of alphas that is centered around the average manager: skilled managers add value at the expense of unskilled managers who hold fewer ideas than the average manager. In contrast, without social interactions, all managers have homogeneous skill and therefore behave like the average manager. A manager's alpha is a noisy measure of her skill. The noise would affect the statistical significance of a manager's alpha. Hence, skilled managers load more aggressively on skill, but also on luck and thus generate a higher, but noisier alpha. In the model, this tension between a manager's skill and luck is captured by the ratio of the two. The ratio is concave in the number of ideas. Because skilled managers generate a noisier alpha, an additional idea improves their alpha t-statistic by less than the alpha it creates. Social interactions improve statistical significance by reducing fundamental noise through increased

price informativeness, but exacerbate noise in skilled managers' alpha by stimulating their trading aggressiveness.

The model indicates that alpha t-statistics have undesirable cross-sectional properties, as they lead the econometrician to understate the fraction of outperforming funds. Controlling for managers' trading aggressiveness can thus reduce this bias, consistent with recent evidence that managers who trade more perform better. The model further suggests that alpha t-statistics have desirable time-series properties, as they deliver a consistent ranking of managers, even when their alphas converge. The model also shows that social interactions may have a considerable effect on statistical inference. Depending on managers' meeting intensity, the econometrician may fail to reject the null hypothesis of zero alpha for a perfect market timer.

One discussant asked why the high-performing manager would ever want to talk to others since it undoes the disadvantage of others. The author noted that in equilibrium people will optimally choose with whom to share information. Another discussant asked that since the number of meeting is random, why the author categorizes it as skill instead of luck in the model. The author answered that he interprets the Poisson arrival of meetings as people actively searching for opportunities. ◆

Strategic Trading in Informationally Complex Environments

Michael Ostrovsky, Nicolas Lambert and Mikhail Panov

The authors study trading behavior and the properties of prices in informationally complex markets. Whether and how dispersed information enters into market prices is one of the central question of information economics. A key difficulty in answering this question is the strategic behavior of informed traders. A trader who has private information about the value of an asset has an incentive to trade in the direction of that information. But the more she trades, the more she reveals the information, and the more she moves the prices closer to the true value of an asset. Thus, to maximize profit, an informed trader may stop short of fully revealing her information, and so the information efficiency of market prices may fall.

The authors present an analytically tractable framework that makes it possible to study trading in such informationally complex environments. The model is based on the single-period version of the linear-normal framework of Kyle (1985). The authors allow for arbitrary correlations among the random variables involved in the model: The value of traded assets, the signals of strategic traders and competitive market makers, and the demand from liquidity traders. The authors show that there always exists a unique linear equilibrium.

In the model, the authors assume that there are several types of agents, with each agent of a given type receiving the same information, and they fix the matrix of correlations of signals across the types. Allowing the numbers of agents of every type of grow, they find that the informational properties of prices in these large markets depend on the informativeness of the demand from liquidity traders. If the demand from liquidity traders is uncorrelated with the true value of the asset or is positively correlated with it, then prices in large markets aggregate all available information. If liquidity demand is negatively correlated with the true value of the asset, then prices in large markets aggregate all available information except that contained in liquidity demand. In both cases, as markets become large, the information possessed by the strategic traders is fully aggregated and fully incorporated into market prices, for very general information structures.

One discussant asked whether there is public information. The author noted that because that the model features asymmetric agents, no public information can be defined. Another question inquired about the origin of the complication in the model economy. The author mentioned that in the model, each agent's decision depends on the belief of other agents' action. When asked whether information is long-lived or short-lived in the model, the author answered that since it is a static model, the amount of information remains actually the same but the size of the market grows bigger. A follow up question inquired, given it is a static model, what would happen if the agent can trade and reveal the results and trade again. The author noted that it can be achieved by analyzing a sequence of economy in the same token. ◆

Trading Costs and Informational Efficiency

Cecilia Parlatore and Eduardo Dávila

Technological advances have reduced exogenous trading costs in financial markets. But has this reduction in costs translated into better information generation and aggregation in financial markets? Has the ability to trade more cheaply encouraged information acquisition by investors? To answer these questions, the authors use a stylized setup that allows them to systematically explore the issue. The baseline model with homogeneous agents and exogenous information sets leads to an irrelevance result in which trading costs are independent of price informativeness. They proceed to analyze the consequences of relaxing the initial set of assumptions and determine the scenarios in which the irrelevance result breaks.

The baseline model portrays a competitive financial market with homogeneous rational investors who trade for two reasons. First, they trade on private information (signal), after receiving private signals about asset payoffs and, second, due to a privately known hedging demand (noise), which is stochastic and uncertain in the aggregate. There are two assets in the economy, a risky and a riskless one. Investors choose their portfolio allocation at date 1 and consume at date 2, based on the maximization of a constant absolute risk aversion (CARA) expected utility. Trading costs are assumed to be quadratic for tractability purposes, but the results extend to linear costs. Information is exogenous to investors.

Under these assumptions and extensions to linear costs, strategic behavior by investors, dynamic economies, and a general utility function, price informativeness is independent of trading costs. The effect of trading costs on how prices aggregate information is a function of how the relevant signal-to-noise ratio contained in asset pricing is affected. The idea is that trading costs equally discourage trading on both information and hedging needs, leaving price informativeness and volatility unchanged.

The authors proceed to explore the validity of the irrelevance result in cases in which agents are heterogeneous in different dimensions. They consider four particular sources of ex-ante heterogeneity: risk aversion in CARA utility, initial asset holdings, precision of their hedging needs, and precision of their private signal. They find that heterogeneity about initial position leaves price informativeness and volatility unaffected by the changes in the level of trading costs. However, under most combinations of parameters involving one-sided deviations along the dimensions of risk-aversion (precision of private signal about the fundamental or precision of hedging needs that generated heterogeneity across investors), higher trading costs are associated with a reduction in price informativeness. This is explained by the correlation in the cross-section of investors between large demand sensitivities and the weight allocated to information relative to hedging by investors, which endogenously emerges from orthogonal heterogeneity along these three dimensions.

The key condition for the irrelevance result is that ex-post demand sensitivities to information and noise respond symmetrically in the aggregate to a change in trading costs. If ex-ante identical investors, for example, receive different signals that create ex-post differential heterogeneity on their demand sensitivities to the fundamental and the noise signal, the irrelevance result breaks. In the benchmark case, ex-ante symmetry implies ex-post demand sensitivities to information and noise react symmetrically, meaning that the irrelevance result is valid.

Finally, the authors allow investors to optimally choose the precision of their private signal, which up to this point was considered exogenous. They consider two cases (i) acquisition of information on the risky asset's payoff and (ii) information about aggregate hedging needs. In both cases, trading costs reduce information acquisition and, consequently, price informativeness, even when price informativeness remains unchanged for a given amount of information. These results suggest that if policy-makers were interested in taxing transactions, it would be optimal to search for markets in which investors have few incentives to acquire information or where agents are very similar, such that higher trading costs won't affect price informativeness. However, it is worth mentioning that they are extremely dependent on how noise is modeled.

Most of the discussion centered in clarifying questions, but there were three comments that stood out. First, Professor Parlatore indicated that in this setting (static and dynamic), equilibrium always exists but it is not unique. A participant asked if she could link this result to previous literature, given that he recalled not seeing this in similar settings. She replied that this is what Manzano and Vives (2011) found, but in their case they cannot guarantee existence. She mentioned that they are interested in exploring the economics behind the multiplicity result and also that this is sensitive to how noise is introduced in the model. There are some parametrizations, however, in which equilibrium is unique. This is the case in instances where risk aversion is either small or very large.

Second, a participant asked if investors would be interested in predicting the dividend or a dividend multiplied by the marginal utility. Professor Parlatore answered that from an external point of view, as it is the case in this setup, they are only interested in the dividend. This is an exercise done from an investor's point of view that is currently not participating in the market and not a social planner. Finally, another participant inquired whether the results would hold for fixed costs. She conjectures that yes, it seems to be true, but have not explored this possibility. ◆

Macro-Financial Volatility under Dispersed Information

Jieran Wu, Eric Young and Jianjun Miao

How - or, rather, why - are aggregate stock prices much more volatile than the expected present value of their dividends? One body of work looks at how agents form expectations about the future. In this environment, dispersion of information across agents plays a role feeding into the volatility of these prices. Wu, Miao, and Young contribute to this line of work by extending the focus to encompass the relatively smooth behavior of macroeconomic quantities (e.g. consumption and output) compared to the high volatility of equity prices. Their main goal is to develop a model that can reconcile the above observations without imposing (ad hoc) exogenous shocks or nonstandard preferences.

There are persistent frictions that generate dispersion of information across agents. This dispersion makes learning relatively slow, exacerbating the volatility associated with idiosyncratic shocks to information used in expectation formation. One important methodological contribution of the authors is that this work combats the difficulty associated with the need for agents to "forecast the forecasts of others." With a unit mass of agents, the state space explodes and becomes intractable to solve. The authors utilize frequency domain methods from harmonic and complex analysis, which get around the aforementioned "time domain" difficulties of forecasting, to allow for closed form solutions where they would otherwise be unavailable.

The model features noisy total factor productivity (TFP) signals to each agent, but these agents cannot distinguish between the common and idiosyncratic components of TFP. Rather, the authors assume that agents make decisions by forming expectations over future dividend flows using an infinite history of these noisy signals. Further, though observed, agents are assumed to not use prior stock and goods price information in forming these expectations because such a scenario would be fully revealing. Though possibly restrictive, the authors argue that this assumption is merely a technical simplification, and only restricts the inclusion of features such as an endogenous signaling process.

The authors find that their model with dispersed information and higher-order expectation dampens the volatility of real variables over the business cycle. The key driver of this result is the assumption that any particular agent has very little information. This makes learning sufficiently slow, such that issues associated with forecasting others' forecasts disappear. Next, the authors show that, under their informational structure, they can guarantee a unique equilibrium in the financial market by making use of time-to-frequency domain transformations of the sort alluded to earlier. It is shown that the volatility of idiosyncratic signals affects the volatility of equity prices positively, which stands in stark contrast to models without noisy signals where prices are unaffected by idiosyncratic prices.

The main mechanism of the model, dubbed the "confusion effect," is that agents cannot detect whether a particular change in the information signal stems from its aggregate or idiosyncratic component. While normally aggregate signals affect equity prices and idiosyncratic signals produce transfers between agents, the confusion allows idiosyncratic volatility to affect equity prices since these errors will end up being correlated across agents.

One concern of conference participants was the exclusion of capital in the model. Its presence would provide a risk-free asset and enable some degree of precautionary savings that, at the outset, would seem to kill some of the results in the paper. The author explained that capital's inclusion would greatly complicate the model and its solution, but speculated that capital would, indeed, erode some of the model's effects. ◆

Heterogeneity and Asset Prices: A Different Approach

Stavros Panageas and Nicolae Garleanu

The authors set out to reconcile asset-price volatility with deterministic aggregate growth and non-volatile changes in consumption and wealth distributions. To do so, they construct a continuous-time, overlapping generations model with imperfect risk sharing and an endowment economy that allows for multiple equilibria.

In the model, agents arrive continuously, have recursive preferences, and face a one-time decision between becoming entrepreneurs or workers when they arrive. Workers have a deterministic income stream, while entrepreneurs can take a risk to produce a "high-productivity" firm or fall short and earn the same income as a worker. The incomes of new firms replace those of existing, older firms – playing to the idea of "creative destruction," in which new innovations both grow the economy and replace existing industry. The conference attendees had a few questions about this aspect of the model. The presenter noted that all new dividend streams are owned by new agents and existing agents do not get ownership of new income "trees."

In this model, the price of a firm is indeterminate. In other words, there exists a continuum of equilibrium paths,

which come from the interactions between discount-rate anticipations and wealth redistribution. This allows for the existence of "sunspot equilibria," in which agents' self-fulfilling perceptions about the economy lead to actual equilibrium paths. The presenter noted that interest rate expectations are very self-fulfilling in the model and are fueled by the actions of the young agents. If young agents expect low interest rates, then they will take the risky entrepreneur path and get richer, decreasing the consumption growth of the older agents, as well as the interest rate.

The source of randomness in the model is from which of the deterministic equilibrium the agents arrive to. This allows the authors to illustrate any process for asset price volatility along with locally deterministic (no instantaneous volatility) consumption and wealth processes. The asset price process is essentially a primitive feature that the authors can specify. This differs from conventional neoclassical models in which asset price volatility is endogenous and linked to volatility in aggregate shocks.

The authors calibrate the model and compare to the data. Their model results in realistic risk premia, interest rate levels and volatility, and returns.

One conference attendee asked what makes this paper different from Constantinides and Duffie (1996). The presenter noted that the papers differ mainly in how the risk premium arises. In the 1996 paper, consumers experience different short-run consumption changes, while in this paper the risk premium arises from consumers experiencing different long-run consumption changes, with short-run changes being deterministic and predictable. ◆

Financial Technology, Unpredictability and Illiquidity in the Long Run

Laura Veldkamp and Maryann Farboodi

In most sectors, technological progress increases efficiency. However, in finance, technology and data-intensive trading strategies may be a cause of market volatility, illiquidity, and inefficiency. In the financial sector, better technology principally delivers more information. When the financial sector becomes more efficient at processing information, the value of information about future dividends, fundamentals, relative to the value of information about order flow, non-fundamental trading, is changed. Therefore, unbiased technological change can explain why financial analysis has shifted from primarily investigating the fundamental profitability of firms to primarily acquiring and processing client order flow data. This sectoral shift in financial analysis can reconcile two seemingly contradictory trends in asset markets: the increase in price informativeness and the concurrent decline in market liquidity.

The authors develop a two-sector growth model of the financial economy to explore sectoral shifts between fundamental information acquisition and order-flow information extraction. The model explains how these shifts can improve market efficiency. But it also shows how and why technological progress can undermine market stability. To explore a shift in information analysis, a new type of information choice model is needed - one that allows investors to choose between styles of financial analysis and then observe the information produced from that analysis, before they invest.

To investigate the evolution of financial analysis style and its consequences, the model has a choice of types of information to analyze, a portfolio choice, and equilibrium asset prices. The market has a single risky asset because the main impacts do not require multiple assets, however, this model can be generalized to a multi-asset setting. The growth model has four key elements: information acquisition and portfolio choice, choice between fundamental and other order-flow information, long lived assets, and long-run growth in technology (more information). The model allows agents to trade off information types in a dynamic model.

Near the no information processing limit, all investors prefer to acquire only fundamental information in this region. This is evidence to show why most capacity is devoted to fundamental information processing at the beginning of the growth trajectory. Next, away from the information processing limit an increase in aggregate information processing increases the value of order flow information, relative to fundamental information. When the financial sector becomes more efficient at processing information, the nature of the equilibrium asset prices changes. This changes the incentives to acquire information about future dividends versus order flow. Therefore, an increase in information processing productivity can explain a shift of financial analysis from investigating the fundamental profitability of firms to a sector that mostly concentrates on acquiring and processing client order flow. The author concludes that this model suggests that if future investors are better informed, future prices will be more sensitive to future shocks, lowering liquidity today. This evidence suggests that improving technology may not improve liquidity. ◆

The Social Value of Financial Expertise

Pablo Kurlat

How large is too large? Moreover, is there some way to answer this question when talking about the size of the financial industry? Indeed, this question has been at the center of a long-lasting debate about the role and scope of the financial industry. One side argues that the current size of the industry is too large: the private rewards generated by these activities exceed the social value. Here, policies that reduce the size, such as higher taxes or capital requirements, would appropriate and serve to increase social welfare. Others, however, argue that these financial activities bring a lot more social value compared to the income they generate.

Kurlat builds a method to assess the optimal size of the financial industry that involves estimating the ratio of the marginal social value to the marginal private value of financial expertise. Assuming that the marginal private value equals the marginal cost, if the ratio is greater than unity then the financial industry is too small (the marginal social value exceeds that of the private value), and that expansionary policies are recommended. If the ratio is less than one, then the financial industry is too large, and policymakers should pursue contractionary policies like higher taxes or more stringent capital requirements.

The model features a continuum of banks that buy assets from households. There are "good" and "bad" assets, which differ in whether they have dividends. Expertise is modeled as a choice that is obtained at some cost. Those banks with high expertise observe more accurate signals about the true quality of the asset. Since all assets trade at the same price, the market for the good asset clears but it does not for the bad asset. In equilibrium, there will be a rationing of bad assets. The "expertise" variable, which is both privately and socially valuable, is of interest in this model. More expertise increases the returns to a bank, reduces the overall information asymmetry, and increases the gains from trade. The author notes that the model, though written for some general assets, may also be implemented in contexts such as venture capital markets or junk bond underwriting.

Analytically, the marginal social value to marginal private value ratio is a complicated object that, in the data, is hard to measure because of various feedback effects. As a result the author derives three sufficient statistics (which are easy to measure) to find an estimate for this ratio. For the first application, to venture capital markets, Kurlat obtains an estimate of the ratio between 0.64 and 0.83, indicating that for the last dollar earned by venture funds, between 64 and 83 cents is value added while the rest are rents. Thus, in context of the overarching question, the venture capital market is too large relative to the socially optimal level. Next, with regard to the junk bond underwriting application, an estimate for the ratio is found to be between 0.09 and 0.26, which also indicates that this industry is too large.

Kurlat finishes the discussion with a comment that the ratio measures the wedge between the marginal social and marginal private values. It is not, importantly, the distance between the equilibrium and optimal levels of expertise, which depends on the steepness of the marginal cost function. ◆

Efficiently Inefficient Markets for Assets and Asset Management

Nicolae Garleanu and Lasse Heje Pedersen

The ability of fund managers to charge large fees to manage investors' assets is puzzling. These fees do not make sense if markets are efficient because managers on average should not improve upon the investment choices of any independent investor. However, the source of inefficiency in asset markets can explain the role for manager fees. If managers can improve upon the returns of an investor by improving the allocation of funds to high return assets, then, in equilibrium, it makes sense that managers will yield these fees. The authors develop a model in which inefficient markets are efficiently managed by managers improve upon asset allocation in exchange for a fee.

There are three layers to their model: an asset market, fund managers, and investors. The asset market is modeled as a Grossman-Stiglitz asset market, where managers can pay a cost to obtain a noisy signal about the payoff of a risky asset. There are investors who give money to managers who then invest in the securities. Only some managers acquire the signal, these are called informed managers, and these managers invest in the most efficient securities. There are also uniformed managers who do not obtain this signal and randomly invest their funds in good and bad securities. Uninformed managers obtain their funds from noise allocators. Active investors give their money only to informed asset managers, who then allocate funds in high performing securities for a fee. This fee is determined via Nash bargaining and the fee is zero in perfectly efficient markets (as no investor will incur a cost to invest through a manager) and it increases with asset inefficiency.

The main friction in the model is that investors must incur a search cost to find an informed manager. When search costs

are high, fewer investors will choose to invest with informed managers, so these managers allocate fewer assets into high performing securities. This leads to less efficient market outcomes. The authors show that lower search costs can improve price efficiency and reduce fees. Moreover, this leads to less performance dispersion among managers and fewer active managers. The authors also do some comparative statics where they reduce asset complexity and thus reduce the information costs. In this case, more investors choose to invest with an informed manager, more managers choose to acquire the signal, price efficiency increases, and fees decline.

The authors also discuss several model extensions. In one extension, they allow for investor heterogeneity in terms of wealth and sophistication, i.e., their manager search cost. In this case, only sufficiently wealthy and sophisticated investors choose to search for an informed manager. They also discuss several empirical implications of their model. Their model implies that investors should be indifferent between active investing and passive, at least in equilibrium, and that asset management fees should be larger for more inefficient assets because of increased informational and search costs. There is some evidence to support both implications.

Overall, the main results of the paper are that markets are more efficient when manager's information costs are smaller and investors search costs are smaller. Also, markets are not efficient and fees exist because managers must be rewarded for becoming informed. Similarly, active investors must be rewarded for the fees they pay and their search costs. ◆

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