Research Statement

My research is in the area of theoretical asset pricing. In particular, I concentrate on two subfields of this general area: *(i)* liquidity, and *(ii)* macro-finance.

As recent events illustrate, market organization can play an important role in the determination of asset prices. My work on liquidity recognizes this fact and models rigorously a variety of market features to derive their implications for pricing, trading, and welfare. Specifically, I study the following frictions to the trading process: search frictions in such markets as the over-the-counter (OTC) ones, where finding an appropriate counterparty and completing a trade can take a significant length of time; short-sale frictions, ranging from outright prohibition to the practical difficulties of borrowing shares to sell short; capital immobility between markets, which generates price effects due to unhedgeable inventory; margin constraints, which affect all market participants, from retail investors to hedge funds; asymmetric information; and transaction costs. I take a general-equilibrium perspective, accounting explicitly for the reaction of market conditions to the actions of agents faced with these conditions. Indeed, the simultaneous adjustment of market conditions — such as price-process properties, market composition, or asset cash flows — constitutes one of the most interesting aspects of the research.

Focusing on frictions makes it possible to address naturally a number of empirical phenomena that have been difficult to reconcile with the classical paradigm in which trading is liquid and joint cashflow-consumption behavior determines asset-price properties. Thus, as I detail below, my work shows that liquidity helps explain pricing and quoting behavior in OTC markets, the time signature of price recovery following allocation or preference shocks, over-pricing following IPOs that decreases over time, occasional high sensitivity of prices to changes in fundamentals, and even seemingly odd features of option prices.

My second major area of research is macro-finance, which lies at the intersection of macroeconomics and finance. The broad goal of this field of study is to explain the joint properties of asset returns, consumption, and production observed empirically, with particular emphasis on the long-run properties. Over the past couple of decades a number of empirical observations have been made that pose challenges to the classical model — for instance, risk premia are high, volatile, and predictable, and interest rates are low and smooth. My work seeks to address these challenges by incorporating agent heterogeneity into the classical model — in terms of preferences, human capital, etc. — or refining the modeling of the production process. This is a relatively recent area of research for me.

Research on Liquidity

Part of my liquidity work studies over-the-counter markets, where numerous assets trade, including corporate and government bonds, mortgage-backed securities, bank loans, emerging-market debt, private equity, real estate, and many derivatives. In a set of co-authored or single-authored papers, I develop rigorous models of OTC markets, concentrating on the time-consuming search for trading counterparties. My work both develops a general framework — also used, subsequently, by other authors — and applies it to several specific

questions.

"Valuation in Over-the-Counter Markets" (Review of Financial Studies, 2007), with Darrell Duffie and Lasse Pedersen, calculates explicitly and analyzes the pricing discounts due to agents' inability to trade an asset as soon as they would like to. Furthermore, the search frictions delay recovery from supply or aggregate liquidity shocks — of the kind currently observed in the market, for instance — generating spike-and-gradual-recovery patterns observed in many markets, from convertible bonds to equities to catastrophe reinsurance. **"Over-the-Counter Markets"** (Econometrica, 2005), also with Darrell Duffie and Lasse Pedersen, shows that search frictions generate market-maker bid-ask spreads that are *lower* for more sophisticated investors. This is the opposite implication to the one made by the classical model of bid-ask spreads, based on asymmetric information, and is supported by recent empirical studies of transaction costs in OTC markets. The framework we develop in these papers has been employed successfully by a number of researchers addressing phenomena difficult to explain otherwise, such as the on-/off-the-run treasury spread, the behavior of market makers around shocks, and the nature of capital flows.

"Liquidity and Risk Management" (American Economic Review Papers and Proceedings, 2007), with Lasse Pedersen, further shows that the interaction between search frictions and risk-management practices can exacerbate the effects of risk: Increased uncertainty, for instance, pushes acceptable asset holdings down, which leaves fewer potential buyers in the market. As a consequence, liquidation takes longer and thus liquidation values are riskier, which further diminishes holdings, and so on. This "risk-management spiral" is a prominent determinant of market behavior during crises, as experienced, among others, on several occasions since August 2007.

In **"Portfolio Choice and Pricing in Illiquid Markets"** (Journal of Economic Theory, forthcoming), I build a search model allowing the study of portfolio choice. I show that the inability to trade sufficiently fast induces agents to take asset positions that are closer to long-run average positions than they are in liquid markets, and therefore generates smaller trades than in liquid markets. This is because, anticipating the possibility of having to hold the current position even when it becomes disadvantageous, both buyers and sellers optimally trade less. In addition, the fact that buyers' and sellers' adjustments to liquidity have opposite signs implies that illiquidity has a smaller price impact when there are no restrictions on asset positions.

Finally concerning search frictions, **"Securities Lending, Shorting, and Pricing"** (Journal of Financial Economics, 2002), with Darrell Duffie and Lasse Pedersen, shows that a search-based security-lending process can increase a stock's price even more than prohibiting shorting outright, due to the lending fees that buyers receive. The paper also predicts prices to fall over time following events such as IPOs, as the shorting demand is gradually filled. The assumptions and results are consistent with the market practices and outcomes during the dotcom boom of the late nineties.

Leverage is one of the phenomena that attracted most attention during the recent financial crisis. In **"Margin Constraints"** (work in progress), with Lasse Pedersen, we study the impact of margin requirements, which are basically limits imposed on leverage, on equity premia and volatility. We show that these constraints can exacerbate the effect of nega-

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tive shocks on return premia: Negative shocks induce the less risk-averse, therefore levered, agents to incur losses, making the margin constraints more likely to bind. Consequently, the less risk-averse agents have to sell part of their holding of risky assets to the more risk-averse agents, who require higher risk premia. Furthermore, the risk premia of assets with more stringent margin requirements increase more. Margin constraints, however, can also dampen asset volatility, as they inhibit the efficient risk-sharing whose dynamic evolution is partly responsible for volatility.

"Demand Based Option Pricing" (Review of Financial Studies, forthcoming), with Lasse Pedersen and Allen Poteshman, also concentrates on situations where risk is not shared efficiently. In particular, it studies the notion that the risk-taking capacity in a given market is fixed — at least, in the short run — and applies the results to options. The model yields that customer demand for an option increases its price by an amount proportional to the variance of the unhedgeable part of the position demanded. It also increases the prices of options with correlated values. The model is compatible with the classical Black-Scholes-Merton option-pricing theory, where positions are completely hedgeable and therefore demand has no price effect. The paper tests the model successfully on a unique data set and shows that it helps explain a number of important option-pricing puzzles. It shows, for instance, that S&P500 options — in particular, puts — are expensive because they are demanded in large amounts, and furthermore that they are more expensive in times when the demand is higher.

My work also studies explicitly the classical trading frictions, namely asymmetric information and transactions costs. **"Adverse Selection and the Required Return"** (Review of Financial Studies, 2004), with Lasse Pedersen, shows that, contrary to some authors' assumption, future adverse selection does not constitute an ex-ante trading cost, even if it will give rise to a bid-ask spread. The explanation is that the expected losses conditional on trading for liquidity reasons are canceled by the gains made when trading based on information. Treating the bid-ask spread as an exogenous cost, therefore, can overstate its price impact. The related paper **"Auctions with Endogenous Selling"** (working paper), also with Lasse Pedersen, compares a number of trading mechanisms from the point of view of the price, volume of trade, and welfare they generate in the presence of both seller and buyer private information.

In a corporate setting, **"Design and Renegotiation of Debt Covenants"** (Review of Financial Studies, forthcoming), with Jeffrey Zwiebel, offers a simple asymmetric-information based explanation to the puzzling fact that debt covenants are very tight, and therefore frequently violated, only to be waived upon violation. We show that if borrowers have private information concerning their ability to extract surplus from the lender at a later stage — for instance, by engaging in asset substitution — then many borrowers would prefer the inefficient outcome of signalling that they are not among the worst by choosing tight covenants.

Transaction costs are at the heart of **"Dynamic Portfolio Choice with Trading Costs"** (work in progress), with Lasse Pedersen. We calculate the optimal trading strategy of an investor who has access to signals predicting the returns of many correlated assets, but also faces transactions costs. The closed-form solutions allow a clear illustration of the dynamic implications of trading costs on portfolio selection and the roles played by such factors as the mean reversion of the return-predicting signals.

Finally, **"Risk and Valuation of Collateral Debt Obligations"** (Financial Analyst Journal, 2001), with Darrell Duffie, proposes a tractable statistical model for the numerical computation of the value of debt obligations collateralized by a large number of correlated underlying assets. This practical problem has been of considerable importance over the past decade, as the market for collateralized debt obligations has increased manyfold.

Research on Macro-Finance

My work in this area proposes several innovations to the classical model aimed at improving its explanatory properties while maintaining transparency and tractability.

"Young, Old, Conservative, and Bold: The Implications of Heterogeneity and Finite Lives for Asset Pricing" (working paper), with Stavros Panageas, rests on three important building blocks: *(i)* agents' risk aversions differ, which generates counter-cyclical risk premia; *(ii)* an overlapping-generations structure where generations are not altruistically linked, which gives agents incentives to save for the old age, when their earning power is lower, thus helping produce a small interest rate, and *(iii)* a production function yielding a pro-cyclical share of firm revenues accruing as profits, which results in volatile cash-flows, and therefore equity returns. The equilibrium outcome is quite similar to the one built by Campbell and Cochrane (Journal of Political Economy, 1999), who ensure consistency with the data through a careful reverse-engineering exercise.

"The Dynamics of Innovation and Asset Returns" (working paper), with Leonid Kogan and Stavros Panageas, is a related piece of research. The paper addresses cross-sectional equity properties in an overlapping-generations model that builds on two observations: *(i)* since technological innovation is more likely to be made by young agents, it benefits these agents disproportionately while eroding profits of the existing firms and the human capital of older workers, and *(ii)* the potential for significant technological innovation characterizes the 'growth', rather than 'value', firms. There are two key implications. First, existing firms do poorly precisely when existing workers, who are marginal investors, suffer, so that the model can generate a significant equity premium. Second, growth firms are a good hedge against marginal-investor financial-wealth and human-capital loss, which constitutes an explanation to the famous 'value-premium puzzle'. We derive novel empirical predictions concerning cohort consumption effects and the value-growth return spread, and find support for them in the data.

In order to concentrate on the role of the production process, **"Technological Growth and Asset Prices"** (work in progress), with Stavros Panageas and Jianfeng Yu, reverts to a representative-agent economy. We propose that productivity not only fluctuates randomly around a deterministic trend, but occasionally experiences discrete transformations. Because these technological improvements take time to perfect and implement efficiently, they generate cyclical and predictable returns. Furthermore, prices lead production and consumption, so that returns covary more strongly with consumption growth cumulated over several quarters than with contemporaneous consumption growth. This property has been documented empirically, but is not explained by existing models.