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February 2007

Research Statement

My research studies how market frictions arise and their implications for financial economics. Said simply, it studies liquidity risk. Whereas classical finance models are based on an assumption of frictionless markets, my research seeks to understand how liquidity risk affects asset prices, risk management, systemic risk, and intermediation in financial markets.

Specifically, my work explores the implications of illiquidity due to transaction costs, predatory trading, margin requirements, unhedgeable inventory risk, search problems, private information, short-sale frictions, and credit risk. For each of these frictions, I try to carefully study its institutional background, capture the essence in a rigorous model, derive the main theoretical implications for financial markets, and test the novel predictions using real data (or at least confront the predictions with existing evidence).

The liquidity-based asset pricing is a significant departure from standard frictionless asset pricing, and, as discussed below, I believe it can help explain the cross section of equity returns (e.g. the high returns of stocks with liquidity risk), the sudden liquidity dry ups that occur across markets, the option pricing puzzles (e.g. the high prices of index options), the valuation and spreads in over-the-counter markets, the time signature of prices in connection with liquidity shocks, and the pricing of hard-to-short stocks and bonds. Below, I briefly discuss each of my papers in turn. Their relation to the liquidity literature is discussed in **"Liquidity and Asset Prices,"** (*Foundations and Trends in Finance*, 2005) a solicited and non-refereed survey written jointly with Yakov Amihud and Haim Mendelson.

My paper with Viral Acharya entitled **"Asset Pricing with Liquidity Risk"** (*Journal of Financial Economics,* 2005) develops a simple equilibrium asset pricing model of liquidity risk in the sense of time-varying transaction costs and derives a liquidity-adjusted capital asset pricing model, showing that three liquidity betas are priced. The model provides a unified theoretical framework that can explain the empirical findings

that return sensitivity to market liquidity is priced (Pastor and Stambaugh, JPE, 2003), that average liquidity is priced (Amihud and Mendelson, JFE, 1986), and that liquidity comoves with returns and predicts future returns (e.g. Jones, Columbia, 2001). The model leads to new empirical predictions that we test in the paper, notable the joint estimation of the liquidity-adjusted CAPM and the importance of a security's liquidity sensitivity to market returns (and effect not studied previously). The paper won the NYSE Award for best paper on equity research at the WFA, 2003, and the Fama/DFA First Prize for best paper on capital markets and asset pricing in the *JFE* 2005.

My paper with Markus Brunnermeier on **"Predatory Trading"** (*The Journal of Finance*, 2005) explores how strategic trading can cause liquidity to vary endogenously. If one trader needs to sell, other "predatory traders" also sell and only subsequently buy back the asset. This predatory trading makes liquidity vanish when it is needed most, leading to price overshooting. What is worse, predatory trading can trigger other traders' crisis, and crisis can spill over across agents and markets, leading to systemic risk. The paper won the Barclays Global Investors Award for the best conference paper at the European Finance Association, 2003, and was nominated for the Smith-Breeden Prize, 2005. The paper provides a new framework for studying strategic interaction among large traders (used in follow-up work by Carlin, Lobo, and Viswanathan (JF, forthcoming) and others) and has important implications for risk management (showing the importance of "dealer exit stress tests"), the granularity of disclosure by hedge funds, and coordinated actions of regulations.

Markus and I continue the agenda on limited capital with the paper **"Market Liquidity and Funding Liquidity,"** in which we show how market liquidity is enhanced by dealers' funding liquidity, that is, their availability of funds. Further, we give conditions under which dealers can borrow more against a liquid security (i.e. face lower margins), so that market liquidity enhances funding liquidity. The feedback between market and funding liquidity leads to liquidity spirals and fragility, that is, sudden liquidity dry-ups. This is consistent with the events following the Russian default in 1998, where the capital loss from the default was small relative to worldwide arbitrage capital, but the ripple effect on market liquidity was large. The model provides a natural explanation of the main empirical features of market liquidity such as its commonality across securities, flight to liquidity events, and the co-movement of liquidity with volatility and with the market. Evidence consistent with the paper's predictions has recently been documented by Hameed, Kang, and Viswanathan (Duke, 2006) and Hendershott, Moulton, and

Seasholes (Berkeley, 2006), and Markus and I are studying how the model can be applied to understand **"Carry Trades and Currency Crashes."** Other related papers include work in progress with Nicolae Garleanu on the asset pricing effects of **"Margins,"** and joint work with Mark Mitchell and Todd Pulvino on **"Slow Moving Capital"** (*American Economic Review, Papers and Proceedings*, 2007), which uses a unique datasets on convertible bond prices and convertible bond hedge funds to illustrate how shocks to traders' capital can depress prices for numerous months before prices rebound. This price pattern is consistent with rising illiquidity as liquidity providers face capital constraints as predicted by the theory described above. I am currently working with Yuliy Sannikov on a theory of **"The Optimal Contract for a Trader"** to explain why capital moves slowly in equilibrium and explore the features of an optimal contract, including an optimal high-water-mark feature.

I apply the general idea that dealers' liquidity provision is limited to derive a new theory of option pricing in a working paper titled **"Demand-Based Option Pricing"** with Nicolae Garleanu and Allen Poteshman. We show explicitly how the pricing kernel is affected by the unhedgeable component of end users' demand pressure. Intuitively, demand pressure for an option increases its price by an amount which is proportional to the size of the demand and the variance of the unhedgeable part of the option. Further, this demand increases the prices of other options with correlated unhedgeable components. The classic Black-Scholes-Merton theory is nested as a special case in which the unhedgeable part is zero and demand does not matter for pricing. In reality, options cannot be perfectly hedged and our model shows generally how demand for many options affect each of their prices. We test the model using a unique dataset that contains aggregate positions of both dealers and end users and show that demand pressure empirically helps to explain some of the main option-pricing puzzles.

I have written three papers on search frictions in financial markets with Darrell Duffie and Nicolae Garleanu. Prior to our work, this was a relatively unexplored area in finance. **"Valuation in Over-the-Counter Markets"** (forthcoming in *The Review of Financial Studies*) shows explicitly how search and bargaining frictions affect asset prices and studies the dynamic price response of large liquidity shocks. **"Over-the-Counter Markets"** (*Econometrica*, 2005) introduces market makers and shows that their bid-ask spreads are in fact tighter when they face more sophisticated investors with better search abilities. This distinguishes the theory from traditional information-based theories of intermediation that imply that more sophisticated (i.e., more informed) investors receive

wider spreads. Our results are consistent with several recent empirical findings, such as those by Green, Hollifield and Schurhoff (RFS, forthcoming).
"Securities Lending, Shorting, and Pricing" illustrates how search problems in securities-lending markets can help to explain recent evidence concerning lending fees, short-selling costs, and asset prices. Short sellers must borrow securities in order to short and finding lendable securities often requires substantial search. If lendable securities are difficult to locate, shorting increases the lending fee. Since the lending fee is an additional income to the asset owner (for institutional investors), it increases the security's value. While conventional wisdom holds that shorting lowers a security's price, we show that shorting can initially elevate the price, and that the price will subsequently be expected to decline over time as the lending fee decreases and short interest increases. This paper won the NYSE Award for best paper on equity research at the WFA, 2002, and was solicited by and published in the *Journal of Financial Economics*. In recent work with Amrut Nashikkar on **"Corporate Bond Specialness,"** I study the empirical determinants of shorting costs, the implications across the markets for corporate bonds, credit default swaps, and equities, and test the predictions of the theoretical models.

Nicolae and I also show that the search framework lends itself to study the interaction of **"Liquidity and Risk Management"** (American Economic Review, Papers & Proceedings, 2007). Interestingly, when search frictions are worse (i.e. liquidity is lower), this amplifies the effective risk of a position by lengthening the time it takes to sell it. We show that this leads to a feedback effect: tighter risk management reduces liquidity, which in turn leads to tighter risk management, etc., which can lead to a financial crisis. Hence, the new finance search literature (including Vayanos and Wang (JET, forthcoming), Vayanos and Weill (LSE, 2006), Weill (UCLA, 2006)) helps to explain a number of phenomena in financial markets that were not well explained by traditional models, including OTC market prices and spreads, short selling behavior, repo rates, the time signature of liquidity crisis, and the interaction with risk management practices.

The paper **"Adverse Selection and the Required Return,"** (*The Review of Financial Studies*, 2004) with Nicolae Garleanu, determines explicitly how private information affects a security's required return and shows how the result differs from models that simply view the bid-ask spread as an exogenous cost. We show that the bid-ask spread generated by adverse selection is not a direct trading cost since an agent's expected losses incurred when trading for liquidity reasons equal his expected gains when trading based

on information. Hence, the spread does not directly influence the required return. Adverse selection does contribute to trading-decision distortions, however, implying allocation costs that increase the required return. In the related paper **"Auctions with Endogenous Selling,"** Nicolae and I study how private information and the choice of real-world auction mechanism affect pricing, volume, and welfare.

Finally, the paper **"Modeling Sovereign Yield Spreads: A Case Study of Russian Debt,"** with Darrell Duffie and Ken Singleton, develops a reduced-form model that accounts for liquidity, default risk, and the risk of restructuring. The study of Russian debt uses a novel estimation method, which can be—and now is—used to estimate affine diffusions in general. The paper is published in *The Journal of Finance* and was nominated for the Smith-Breeden Prize, 2003. I continue the research on liquidity and credit risk in recent work in progress with Francis Longstaff, Jun Pan and Ken Singleton on **"How Sovereign is Sovereign Credit Risk?"**