Ioanid Rosu has studied how limit order books (orders to buy or sell stock at predefined prices) are established and evolve. Rosu shows that contrary to other types of stock market order, limit order books vary according to degrees of investor patience and competition rather than according to informational asymmetry.

Ioanid Rosu presents a model of price formation in an order market where trading is conducted according to a limited-order book. This refers to orders (placed by an agent) to buy or sell stock at a certain price, thereby guaranteeing investors that shares will not be sold (or purchased) below (or above) a predefined price. Contrary to price-driven markets, where market makers provide liquidity and thus establish rates, there are no market makers in order-driven markets. Liquidity arrives on the market randomly, as anonymous traders place orders in a limit-order book and wait until the transaction goes through. Rosu comments, "I got involved in this issue almost by chance. When I started the study, I did not know how investors placed limit-orders. I was primarily interested in financial market liquidity and information-related costs, but I realized that on many markets, it is waiting costs that have the greatest impact. In fact, there was an apparently critical issue that I knew nothing about—financial market microstructure. How are prices formed? What can we learn from this? And how does this affect the economy?"

**CREATING A MODEL FOR THE LIMIT ORDER MARKET**
"Over half of the world’s stock markets are currently order-driven, and limit-order books lie at the very core of the trading system,” Rosu explains. "But despite their significance, there is very little related literature. One reason is that order markets are complex and difficult to represent with a model.” Contrary to price-markets, where just one or a few market makers are enough to create a model, a satisfactory model of the order-market requires showing how market prices are formed based on the interaction of a large number of anonymous traders that arrive on the market randomly and can choose to either buy or sell immediately, or to wait. Waiting enables them to invest strategically and change their orders at any time. "We propose a model where, for the first time, agents can freely change or cancel limit-orders. What is surprising is that allowing traders to adopt a strategy has actually simplified the issue instead of making it more complicated.”

**TIME IS MONEY**
Rosu’s model offers insight about differences between buying and selling prices (the bid-ask spread), trading volume, the impact of transactions on prices, and the evolution of order books over time. Some of his findings explain empirical observations of order markets, and others are brand new and can be used to test the model. Rosu stresses that his results were obtained in the absence of

**BIOGRAPHY**
Romanian national Ioanid Rosu joined the HEC Paris faculty in 2010 after having taught finance at the University of Chicago (Booth School of Business). Rosu holds PhDs in mathematics and in financial economics from MIT, where he received several research grants as well as the Charlie Housman Award for Excellence in Teaching.
asymmetrical information between traders. This is an advantage, because it is difficult to measure and almost impossible to observe the asymmetry of information. "I was actually surprised that the model worked. According to what I had read on the subject, limit-orders are placed at different levels, and investors wait to execute them out when they think that the people who place their orders immediately have better information than they do. But I realized that people who postpone transactions consequently incur waiting costs. Time is money. So traders place limit orders at a range of levels, because they need to be compensated for waiting periods."

THE IMPACT OF COMPETITION ON PRICES
This situation directly affects the limit-order market and book form. Compensation depends on the difference between limit-order prices, so when there is more activity on the market (traders arrive on the market more quickly), liquidity suppliers are compensated less (spreads are smaller) and wait for shorter lengths of time. In such conditions, a market is considered to be liquid when it is quick and/or competitive. This contrasts with models based on the presence of asymmetrical information, where a market is liquid when asymmetry is weak. "A quicker, more active market tends to be more liquid and its order book is fuller," says Rosu. "I actually tested notion in another study on the influence of the weather*. Still, the dynamic I have described cannot be held as an absolute, because the opposite might also occur. A quicker market could indicate that some investors have better information, and others would wait out of fear."

Generally speaking, Rosu’s study shows that greater activity and competition generate smaller bid-ask spreads and have a limited impact on prices. On the other hand, market orders have a greater spread and provoke price increases. Rosu’s study also explains why buying and selling orders sometimes collectively stray from the spread and give limit order books a humped shape. "This has previously been shown, but no one had explained or quantified the phenomenon," says Rosu. Buying and selling prices are also subject to a co-movement effect, even in the absence of asymmetrical information. Finally, investors place orders quickly when order books are full. Such orders frequently appear on order markets, but it has been difficult to come up with a rational explanation for them. In this model, they are explained quite simply by strategic considerations related to waiting costs.

APPLICATIONS FOR INVESTORS
The study offers valuable insight about liquidity traded on order markets and shows the related effects on financial asset prices and therefore on investor decisions. It enables banks and traders to better understand how these markets work and issues like spreads, trading volume, transaction-prices relationships, and order book evolution over time. Finance professionals can use this information to more effectively respond to investors’ needs.