

RESEARCH STATEMENT

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I. An Overview: Themes that run through my research

Every expectations operator, every variance and every covariance is conditioned on an information set. Therefore, every dynamic model makes assumptions about what information agents use when they forecast future events. Most macroeconomics and finance theories employ stylized informational assumptions: common knowledge, complete information about all past events and no additional information about any future events. But the dynamics of choice variables rest on these assumptions. While preferences have been re-examined and technologies have been refined, relatively little work has investigated agents' information sets. My research shows that simple models of information transmission can address many outstanding puzzles in macroeconomics and finance. I model information in three ways: connecting information to the aggregate level of economic activity, selling information in competitive markets, and information choice.

Connecting Information and Economic Activity

My first two papers explain the asymmetry in asset prices and business cycles by connecting information flow to the level of economic activity. In "Slow Boom, Sudden Crash," information production is a by-product, or positive externality, of economic activity. In booms, ample economic activity produces abundant information. When a boom turns to a slump, a large data set alerts investors to the change with high degree of accuracy; investors respond decisively. In a slump, less economic activity generates less information. If the economy improves, the lack of data slows investor reactions, making the boom more gradual. "Learning Asymmetry in Real Business Cycles" uses variations in signal quality, rather than variations in the number of informative projects undertaken, to explain asymmetries in output, investment and employment.

In "Nature or Nurture," the economic activity observed is female employment: Women only learn about the effect of maternal employment if they observe the children of employed mothers. The fact that few mothers are employed early in the century slows learning and generates a realistic s-shaped time series for female labor force participation. "The Geography of Female Labor Force Participation" adds a spatial dimension to this learning process to explain the clustering of high participation regions.

Information Markets and Hidden Complementarities

My second line of research examines a complementarity that arises when information is sold through a market. Asset market frenzies bear the hallmarks of coordination games: investors seem to want to buy at the same time and acquire the same assets as other investors. "Media Frenzies in Markets for Financial Information" shows that increasing returns to information naturally generates the requisite complementarity. Because of its high fixed cost, information that few people purchase is expensive; information sold to many is cheap. The low price encourages investors to buy information that many others also buy. Investors who observe the same information will want to buy and sell the same assets. What is really information complementarity mimics investment complementarity.

"Aggregate Shocks or Aggregate Information" tackles the question of why expansions and contractions are so synchronized across industries. While previous work debated the size of production complementarities, this model uses information complementarity instead. When firms purchase cheap, aggregate information but remain ignorant of their sector-specific shocks, their output reacts only to aggregate shocks, leaving it highly correlated across sectors. In "Information Markets and the Comovement of Asset Prices," it is not the agents, but the asset prices that

behave similarly. This happens when agents observe signals they can use to infer the values of many assets. Competitive information markets supply signals with precisely this property.

Information Choice

“Information Acquisition and Portfolio Under-Diversification” shows how information acquisition choices interact with investment decisions to create gains to specialization. Specialization in learning about a small set of assets causes investors to over-weight those assets, relative to what a standard portfolio model would predict. “Information Immobility and the Home Bias Puzzle” extends this insight to a two-country setting where learning magnifies small initial differences in agents’ information sets. Jointly analyzing information choice and portfolio choice can explain a broad set of facts relating to patterns of foreign investment, own-company stock bias, and excess returns on locally-biased portfolios, all within a fully rational, general equilibrium framework.

In the models of information markets and information choice, externalities make learning strategic. For example, in the previous two papers, investing and learning are strategic substitutes: If many others want to buy an asset, its price rises; since agents don’t want to buy the expensive assets others are investing in, they don’t want to learn information that others know. This is why investors don’t specialize in the same assets and don’t hold the same portfolios. To understand the general connection between the strategic motives in actions and in information acquisition, “Knowing What Others Know” examines information acquisition in a Morris and Shin (2002)-style strategic game. It shows that the strategic motives in action games are systematically passed on to information choices, but that information choice can generate multiple equilibria. Ideas about the interaction between coordination games and information choice that came out of this project re-emerge in subsequent work on labor force participation and on leadership.

Why study endogenous information?

One objection to this line of research is that basing theories on unobservables, like information, makes for un-testable models and vacuous theory. Yet, this argument highlights why theories of endogenous information are so important. It is the standard models, the ones that make stylized assumptions about information endowments, that offer no way to test these assumptions. Micro-founded theories of information transmission that deliver information sets as equilibrium outcomes are a solution to this problem. By linking information outcomes to fundamentals – for example, how much is produced, how volatile productivity is, or how many other people benefit from that information – these models begin and end with observable economic variables. Observables predict information patterns, which in turn, predict other observables. This makes for testable hypotheses. Thus a contribution of my research is that it brings information-based theories, previously deemed un-testable, to the data.

Although all my research uses endogenous information, it spans many topics: business cycles, monetary economics, labor, financial markets, international economics and coordination games. Below I describe the contribution of each paper and plans for future work, organized by topic.

II. Financial Markets

Each of the three themes that run through my research was first developed in a model of financial markets and later applied to macroeconomics. Settings where agents trade endowments make for simple laboratories to explore the effects of endogenous information. Furthermore, an existing literature on asymmetric information in financial markets provided a foundation, on top of which I could build models of endogenous information.

1. Slow Boom, Sudden Crash

Journal of Economic Theory, 2005

Prices in financial markets rise gradually, but experience occasional sudden crashes. Why do financial markets exhibit this asymmetry? The main idea is that when agents learn more about the state of the economy, they respond more decisively to state changes. They learn from seeing outcomes of investment projects, but cannot observe outcomes of unfunded investments. In good times, investment activity generates information as a by-product, which accelerates learning and accelerates reactions when the state changes from good to bad. I test the cross-sectional predictions of the theory with data from U.S. and emerging credit markets.

2. Media Frenzies in Markets for Financial Information

American Economic Review, 2006

Emerging equity markets witness occasional surges in the price level (frenzies) and increases in cross-market price dispersion (herds), accompanied by a flood of media coverage. Many papers alter preferences, investment constraints or shock distributions to generate complementarity. Adding a competitive market for information provision to a Grossman-Stiglitz (1980) –style model allows the model to explain these anomalies. Because information has a high fixed cost of production, its equilibrium price is low when quantity sold is high. Investors all buy the same information because the information others buy has the lowest price. By lowering risk, information raises the asset's price. Given two identical assets, investors herd: one price is higher because abundant information about that asset reduces its payoff risk. Transitions between low-information/low-asset-price and high-information/high-asset-price equilibria create price paths resembling periodic frenzies. To test the model, I collect panel data on the number of financial news articles reporting on 23 emerging markets. The results show that when asset market volatility increases, news coverage intensifies, and that more news is correlated with higher asset prices and higher cross-market price dispersion.

3. Information Markets and the Comovement of Asset Prices

Review of Economic Studies, 2006

The high covariance of asset prices, relative to the covariance of their fundamentals, seems to defy rational explanation (Pindyck and Rotemberg, 1993). This paper explores whether information observed by investors, but not known to the econometrician, is a possible explanation. This explanation has not been widely accepted because, without data on investors' information, it cannot be directly tested. This paper circumvents that problem by showing that in equilibrium, a micro-founded information market supplies precisely the kind of information that generates comovement. Cross-sectional, business cycle frequency, cross-country and long-run predictions of the theory are confirmed in the data. Evidence that prices of high-comovement assets contain less information about future firm earnings and that such assets are less likely to be covered by analysts further solidifies the link between comovement and information frictions.

4. Information Acquisition and Under-Diversification

Working paper (with Stijn Van Nieuwerburgh)

If an investor can learn about asset payoffs before choosing his portfolio, which assets should he learn about? This paper offers an answer to that question. Scale economies in information acquisition make specialization optimal. The investor should learn about a set of highly-correlated assets. Knowing more about these assets makes them less risky and more desirable to

hold. Benefits to specialization compete with benefits to diversification. The resulting asset portfolios appear under-diversified from the perspective of standard theory, but are optimal. Predictions for patterns of expected portfolio returns and equilibrium prices are confirmed.

5. Inside Information and the Own Company Stock Puzzle

Journal of the European Economic Association, P&P, 2006 (with Stijn Van Nieuwerburgh)

The previous paper raises a question: How does labor income risk change an investor's learning and investment strategy? Diversification tells the investor to short-sell his own company's stock to hedge his labor income risk. This model shows that employees may choose to learn own-firm information because it also reveals their future labor income. Learning reduces uncertainty, which lowers the employee's risk thus raising the risk-adjusted return on own-firm equity. If this learning effect is strong, it can make observed long positions optimal.

The next step in this line of research is to merge the portfolio theory of individual information choice from (4) with the information markets insights from (2), to generate an equilibrium theory of market-provided financial information services.

III. Business Cycles

Endogenous information production is the key element in understanding long run growth (Romer, 1990). Accumulating information can achieve what accumulating physical goods cannot because of its increasing returns: information is costly to produce but free/cheap to replicate. In contrast, most theories of short-run fluctuations neglect information. Despite the fact that one explicit aim of the real business cycle literature was to model short-run and long-run growth with the same tools, information fell by the wayside. My work on business cycles shows how ideas about information dynamics in financial markets can resolve puzzles about short-run fluctuations. In moving from financial endowment economies to general equilibrium production economies, new challenges arose. Additional market prices reveal information, countervailing equilibrium effects can arise, and calibration demands new ways of measuring agents' information.

6. Learning Asymmetries in Real Business Cycles

Journal of Monetary Economics, May 2006 (with Stijn Van Nieuwerburgh)

This paper uses a similar idea as in (1) to explain the gradual booms and sharp contractions in business cycles. But a model whose key state variable is the number of investment projects undertaken is not compatible with standard business cycle calibration techniques. Therefore, we devised a new way to link information precision to economic activity through the production function. Agents observe output and inputs but cannot perfectly distinguish productivity, which is multiplied by the production function, from additive transitory output shocks. When agents believe that productivity is high, they work hard and invest. Because high production amplifies movements in productivity but leaves the variance of noise unchanged, productivity becomes easier to observe. The noise is calibrated to match the variance of professional GDP forecasts.

7. Aggregate Shocks or Aggregate Information? Costly Information and Business Cycle Comovement

Journal of Monetary Economics, forthcoming 2007 (with Justin Wolfers)

Synchronized expansions and contractions across sectors define business cycles. Yet synchronization is puzzling because productivity across sectors exhibits weak correlation. This paper uses the information complementarity in (2) to explain the apparent coordination across

sectors. Sectors can share the cost of acquiring aggregate information, rather than each paying the full production cost to forecast their sector-specific productivity. Sectors with common, aggregate information make highly correlated production choices. By filtering out sector-specific shocks and transmitting aggregate ones, information markets amplify comovement. Using calibration techniques similar to (6), our model generates as much comovement as in business cycle data.

IV. Monetary Economics

Much of the work on learning in macroeconomics has addressed monetary phenomena. Recent examples include models of costly learning by price-setters (Reis 2006), learning by central banks with misspecified models (Sargent 1999), and price-setting with heterogeneous information (Lorenzoni 2006, Hellwig 2006). The following two papers contribute to that literature.

8. **Knowing What Others Know: Coordination Motives in Information Acquisition**

Third round at Review of Economic Studies (with Christian Hellwig)

This paper derives general properties of strategic models with information choice; it uses these results to describe what features an information-choice, price-setting model needs for it to deliver unique equilibria with smooth price adjustment after a monetary shock. The general idea is that when a large number of agents play a game with strategic complementarity (like price-setting), information choices exhibit complementarity as well: If an agent wants to do what others do, they want to know what others know. This makes heterogeneous beliefs difficult to sustain and may generate multiple equilibria. In models with substitutability, agents prefer to differentiate their information choices.

9. **Income Dispersion and Counter-Cyclical Markups**

Working paper (with Chris Edmond)

This project starts from the idea that more uncertainty in recessions (as in 1 and 6) creates a form of endogenous price rigidity. Specifically, if sellers are more uncertain about each buyer's income because incomes are more dispersed, then the optimal markup charged by monopolistically competitive firms rises. The reason is that when incomes, and thus willingness to pay, are more dispersed, the aggregate elasticity of demand falls. To quantify the model's effects, we use estimates from Storesletten, Telmer, and Yaron (2004), who show that dispersion rises in recessions. Adding counter-cyclical income dispersion enables a neoclassical business cycle model to simultaneously explain markup fluctuations and standard business cycle quantities.

VI. International Economics

Because most people know much less about foreign countries than they do about their own, asymmetric information in international economics is an active research area (e.g., Bacchetta and van Wincoop 2006). Endogenous information gives these theories more predictive power because it tells us which information asymmetries are likely to be operative. The ideas of scale economies in information and specialization re-emerge here and help to explain why seemingly small differences in initial conditions across countries can have large effects on economic choices.

10. **Information Immobility and the Home Bias Puzzle**

Second round at Journal of Finance (with Stijn Van Nieuwerburgh)

Investors profit most from information that is very different from what other investors know. Therefore, if a home-country investor starts out knowing more than foreigners do about the future

payoffs of home assets, their optimal research strategy is to build on that information advantage, learn more about home assets, and hold more home assets on average.

11. Learning About Reform: Time-Varying Support for Structural Adjustment

International Journal of Finance and Economics, accepted 2007

Why does public opinion about a structural economic reform occasionally reverse itself, without any provocation? In the model, structural adjustment causes temporary unemployment. The unemployed gradually learn about when they will be re-employed. As labor markets adjust and the cost of reform is revealed, support can gradually rise, it can remain low and suddenly rise, or there can be a quick reversal of support for a previously popular policy. This was a chapter in my Ph.D. dissertation.

12. Exports and Expectations: A Theory of Trade in Goods and Information

Work in progress

Empirical models of international trade find that small differences in distance have large effects on trade volume. This is true even for goods and services for which transportation costs are quite low. Increasing returns to specialization could explain this pattern. Countries value information about trading partners' future productivity because it forecasts their own terms of trade. The higher the trade volume, the more valuable is the information. But, countries that know more and better anticipate terms-of-trade shocks get higher benefits from trade and trade more. Thus, more trade leads to more information acquisition, which leads to more trade. Just like investors specialize in learning about assets in (3), countries specialize in learning about and trading with a few nearby countries because nearby countries are the ones they initially expected to trade more with. Because of increasing returns, small differences in initial benefits from trade have large effects on realized trade volumes.

V. Labor Economics

Cultural beliefs govern all kinds of economic decisions. Female labor force participation is one example. Yet culture is often sidelined in economics because it is hard to measure and its effects are difficult to model. The next two papers use Bayesian learning tools to model cultural change and its effect on labor force participation.

13. Nature or Nurture? Learning and Female Labor Force Participation

Working paper (with Alessandra Fogli)

In the last century, the evolution of female labor force participation has been S-shaped: It rose slowly at first, then quickly, and has leveled off recently. Central to this dramatic rise has been the entry of women with young children. We argue that this S-shaped dynamic came from generations of women learning about the effect of maternal employment on children's outcomes. Each generation updates the beliefs of their parents, by observing the outcomes of employed mothers' children. When few women participate, most outcomes are uninformative and participation rises slowly. As information accumulates and the effects of maternal employment become less uncertain, more women participate, learning accelerates and labor force participation rises faster. As beliefs converge to the truth, participation stabilizes. Calibrating to 1940 labor market conditions yields predictions consistent with surveys, wages and participation rates.

14. The Geography of Female Labor Force Participation and the Diffusion of Information

Working paper (with Alessandra Fogli and Stefania Marcassa)

Using empirical techniques developed by geographers, this paper documents spatial patterns of U.S. female labor force participation. The excess spatial correlation we document supports theories that use a positive local externality to explain rising participation. For such a theory to simultaneously explain the heterogeneity in participation growth, it must also have a friction that prevents instantaneous coordination. We formulate a model of local transmission of information about the effects of maternal employment and show that it can replicate the evolution of geographic patterns over time. Localized information transmission helps to explain why social norms change so slowly, even though Bayesian learning generally converges quickly.

One role of culture is to create norms that coordinate actions. The next step in this research agenda is to explore the interaction between local information diffusion and coordination. Local coordination motives would rationalize the choice to learn about local outcomes, instead of aggregate statistics. At the same time, local information would make local actions more similar, reinforcing coordination. Both effects would slow down changes in beliefs and explain the enduring persistence of culture.

VI. The Role of Information in Coordination Games

One of the literatures closest to my research area focuses on the role of heterogeneous private information and public information in coordination games (e.g., Morris and Shin 2002). “Knowing What Others Know” was an opportunity for me to explore the links between information choice and this literature. The last paper uses the tools of global games to answer a distinctly different question: What beliefs should a good manager have?

15. Leadership, Coordination and Mission-Driven Management

Working paper (with Patrick Bolton and Markus Brunnermeier)

A good leader coordinates his followers by making a precise mission statement, which credibly communicates the optimal course of action. In practice, leaders don't know what the optimal action is and are constantly learning about it. Learning creates a time-inconsistency problem because the leader has an incentive to commit to a mission to achieve coordination and then adjust it when new information arrives. Overconfidence is a valuable attribute in such a setting, since it helps the leader stick with his prior belief. Even with a costly commitment technology available, overconfident leaders still facilitate better coordination and teamwork. The drawback of overconfidence is that it inhibits learning from the followers' actions. Hence, it is costly when followers have sufficiently informative signals.