Yeji Sung
419 West 119st Apt 1F
New York, NY, 10027
917-999-8436
ys2992@columbia.edu

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I have a problem with the rational expectation hypothesis. My dissatisfaction comes less from the fact that it is a strong assumption, but more from the fact that it is such a dominant framework that a menu of expectation formation models is not actively utilized. However, I notice that we see more debate about alternative models and introduction of more sophisticated models that improve our state of knowledge.

This is why I would love to participate in the Behavioral Macroeconomics Research Boot Camp; having an opportunity to learn from and interact with professors who are actively pushing the boundary of the field will help me grow. Professor Michael Woodford supports my decision and is writing a letter for me.

During my graduate program, I also worked on developing alternative models to rational expectations model. In a joint work with da Silveira and Woodford, we explore the role of imperfect memory to explain the over-reaction to recent news. I am also working on applying this theory to asset-pricing literature, the goal of which is to jointly replicate the asset price dynamics and the expectations survey.

Thank you very much for your time and consideration. I look forward to hearing from you.

Yeji Sung

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Columbia University
Department of Economics
420 West 118th St.,
New York, NY 10027

ys2992@columbia.edu
https://yejisung.github.io

Education

Columbia University, Ph.D., Economics, 2016-present; M.A., Economics, 2017.
Seoul National University, M.A., Economics, 2015; B.A., Economics, 2013.

Courses Completed

Microeconomic Analysis 1&2, Macroeconomic Analysis 1&2, Introduction to Econometrics 1&2, Math Methods for Economics, Advanced Macroeconomic Analysis, Macro-Econometrics, Behavioral Economics, Empirical Corporate Finance, Advanced International Macro, Topics in Health Economics, Computational Models of Perception and Choice

Fellowships and Grants

Program for Economic Research, Columbia University, Research Fellow Grant, 2019.
Program for Economic Research, Columbia University, Data Grant, 2018.
Ilju Academy and Culture Foundation, Ph.D. Fellowship, 2016-2020.
GSAS Dean's Fellowship, Columbia University, 2016-2021.

Publication

"The Relevance of the FTPL in Korea"
Journal of Economic Theory and Econometrics 26(1): 1-34, March 2015.
(with Jungsik Hyun, Jung Yi Hong, and Jae Won Lee)

Work in Progress

"Noisy Memory and Asset Price Fluctuations"

I propose a dynamic equilibrium model of stock market prices and trading volume in which investors face limitations in their precision of their memory of past data (modeled as random noise in the information about prior cognitive states that can be recalled from memory). As a main component of the model, I first introduce the noisy memory model of da Silveira and Woodford (2019) into an otherwise standard consumption-portfolio model. I then show how investors forecast asset prices based on their noisy memory when interacting in the stock market. The model predicts similar price dynamics to the kind that other authors have attributed to extrapolative biases in expectation formation; but the formulation offered here has the advantage of (i) providing an explanation for the extrapolative bias, as a consequence of optimal decision given the noisy memory, and (ii) predicting the joint movement of asset prices and trading volume. The model also differs from other explanations of asset mis-pricing based on Bayesian learning in that the biases are predicted to persist even in the long run when investors have had extensive prior experience with price and earnings fluctuations.

"Optimally Imprecise Memory and Biased Forecasts"
(with Rava Azeredo da Silveira and Michael Woodford)

We propose a model of optimal decision making subject to a memory constraint, in which the structure of the imperfect memory is also assumed to be optimal (for a given class of possible decision problems) within a very flexible class of possible memory structures. The constraint is a limit on the complexity of

memory measured using Shannon's mutual information, as in models of rational inattention. We show that the model implies that both forecasts and actions will exhibit idiosyncratic random variation; that beliefs will fluctuate forever around the rational expectations (perfect-memory) beliefs with a variance that does not fall to zero; and that more recent news will be given disproportionate weight. The model provides a simple explanation for a number of systematic biases that are observed of people's expectations in laboratory and field settings. We also analyze the model's implications for an optimal consumption-smoothing problem, and show that it predicts departures from the Hall (1978) random-walk model of consumption of a kind that cannot be captured by the Sims (2003) model of consumption smoothing with rational inattention.

"The Effects of TLTRO2 on the Italian Credit Market" (with Lucia Esposito and Davide Fantino)

When banks' funding problem becomes severe, central bank seeks for a well-designed policy that can boost bank lending. This is what the European Central Bank did in the aftermath of the sovereign debt crisis by launching a lending program for commercial banks. Using an extensive credit registry data from the Bank of Italy, we evaluate the effectiveness of this program on encouraging lending to firms and households.

"Simple Inflation Targeting: an Acceptable Second Best?" (with Jae Won Lee)

In theory, the central bank can improve welfare by targeting an optimally constructed inflation index which puts disproportional weight on sectors with slow price changes. However, the central bank in practice targets a simple-weighted inflation index. We show that whether this form of simple inflation targeting may or may not serve as a reasonable monetary policy depends on the level of financial and trade friction across sectors.

"Inflation Targeting in Fragile Monetary Union" (with Jae Won Lee)

Monetary policy may not affect countries in a monetary union the same way. We propose a model where countries can leave the monetary union if the welfare outside the union is bigger. The model implies that the central bank in a monetary union cannot disproportionately favor one country over the other. We show the range of inflation index the central can construct when facing such a constraint.

Teaching Assistance

Columbia University
Money and Banking (2019), The Psychology and Economics of Consumer Finance (MBA; 2019, 2018), International Trade (2017)

Seoul National University, 2013-2016.
Principles of Economics, Introductory Statistics for Economists, Microeconomics, Macroeconomics, Advanced Macroeconomics (Graduate), Applied Macroeconomics (Graduate)

Research Assistance

2018-2019: for Michael Woodford.
2017-2018: for Adam Guren, Emi Nakamura and Jón Steinsson.
2014-2016: for Jae Won Lee.

Workshop and Conference Presentations

2019: The Sloan-Nomis Workshop on the Cognitive Foundations of Economic Behavior,

Young Economists Symposium
2016: The Econometric Society Australasia Meeting
2015: Korea's Allied Economic Associations Annual Meeting

Expectation formation in macroeconomics
Yeji Sung

Throughout my doctorate program, I'd like to have a better understanding of when and how to deviate from the full-information rational expectations. The rational expectations hypothesis has served the profession for a generation, enabling researchers to develop sophisticated dynamic models under a well-specified expectation benchmark. Such a heavy reliance of the profession on a single assumption does have a good side. Modern macro models are typically a big system of equations, which means simplification of some sort is inevitable. Since rational expectation hypothesis is a widely used simplification assumption, researchers could take the assumption without having to worry about how to communicate it. However, as is the case in any other theoretical researches, we'd like to know when and if a big assumption better be relaxed. And to know if this assumption is a strong one, a model should be written down explicitly so that we can compare the different predictions arising from different assumptions.

In the previous years, I have worked in developing an alternative model to the full information rational expectation models. In "Optimally Imprecise Memory and Biased Forecasts" (with Rava Azeredo da Silveira and Michael Woodford), we propose a model of optimal decision making when a decision maker faces a limit on the complexity of memory. The optimal imprecise memory structure implies that both forecasts and actions exhibit idiosyncratic random variation which fluctuates forever around the rational-expectations beliefs. The model provides a simple explanation for a number of features of observed forecast bias in laboratory and field settings. Based on the imprecise memory model above, I propose a model of optimal consumption and portfolio choice in "Noisy Memory and Asset Price Fluctuations". The model implies that asset prices are more volatile and over-reacting to recent information compared to what would be the case under the rational-expectations beliefs. This model generates a realistic price dynamics without making conventional assumptions.

In the future, I would like to put an effort to better understand when and how we should be careful about the expectation assumption in macroeconomic modeling. As a first step, I want to focus on measurement of expectation and then figure out the specification that best describes the measured expectations.

Through a controlled lab experiment, I would like to measure a decision maker's probabilistic perception of a single random variable. One example in mind is a task to forecast a variable after observing past realizations of the variable. This kind of task is of particular interest in macroeconomics because the forecast of future variables governs the intertemporal decision-making. Furthermore, theories that deviate from the full-information rational expectations make a sharp prediction about the forecast of future

variables. Therefore, a high-quality expectation data could shed lights on which theories are useful at which scenarios.

Most experimental and survey results elicit the expectations by asking respondents a numerical estimate of certain features of the probabilistic distribution. For example, a respondent is asked to provide her estimate of the mean, mode, variance, or confidence interval in a numerical scale. When researchers seek to elicit an entire probability distribution of the random variable, a respondent is asked to plot a histogram by assigning probability mass to a pre-specified number of beans.

The traditional expectation elicitation method relies on two implicit assumptions. One assumption is that respondents hold a well-specified belief distribution in mind and make decisions based on that probability distribution. The other assumption is that when asked about the numerical feature of the distribution, a respondent can indeed spell out the numbers with ease. If either of the two assumption fails to hold, it would be difficult to interpret the elicited expectation as the true subjective expectation. This is going to be more problematic if the elicited expectation cannot be validated with other sets of data. For example, when the experimental or survey research gather data on both expectation and decision-making, one might be able to validate the quality of expectation data by checking whether the expectation and decision-making data have a sensible correlation. However, it is typically the case that many surveys would elicit expectation alone.

One might wonder if a researcher could elicit expectations without explicitly asking about them. One possible method is to provide a menu of bets to a respondent so that she can choose whether to take a bet or not based on her existing heuristic way of thinking about the probabilistic situation. For example, one could try to trace out the distribution function by asking respondents whether they will take a bet that gives x dollar when the realized random variable is below certain value r and 0 dollar otherwise. If one asks this question repeatedly at a different x and r, one could trace out the entire distribution. Or, one could vary the mean and variance of the bet and ask respondents to choose a bet one will take.

Once equipped with the elicited expectations, the goal is to tell apart different theories that deviate from the full information rational expectation hypothesis. In parsing out different theories, it is useful to vary the treatment so that I could decompose the deviation from the rational expectations into different sources. This may be feasible by manipulating whether someone has a more perfect memory, or more incentive to pay attention. The goal of this treatment would be to capture the different systemic bias of the expectation revision after an observation is realized, and attribute this different response as a source of the deviation from the rational expectations. Another goal would be to have a better understanding of the heterogeneity of the expectation. These exercises would help nail down the specification of expectations and shed lights on which theory seems more relevant in explaining the aforementioned setting.

Note from Elisa: Michael Woodford thought he sent the letter but I did not receive anything. He asked if we could use the letter he wrote for the fellowship in spring 2019 instead. This is the one.

COLUMBIA UNIVERSITY
IN THE CITY OF NEW YORK
ECONOMICS

New York, NY 10027
May 20, 2019

Selection Committee
Behavioral Macroeconomics Dissertation Fellowships
National Bureau of Economic Research
Cambridge, Massachusetts

Dear colleagues,

I am writing to recommend Yeji Sung, a rising fourth-year PhD student in Economics at Columbia, for an NBER Behavioral Macroeconomics Dissertation Fellowship. Yeji is an outstanding student, one of the two strongest macroeconomics dissertation writers in her cohort, with interests in the general area of macro-finance. She also has a strong interest in behavioral issues, and has taken all of the PhD-level courses in behavioral economics offered at Columbia (courses taught by Mark Dean and myself). In addition to regular participation for the past two years in the colloquium for macroeconomics dissertation writers organized by Jennifer La'O, Hassan Afrouzi and me, she is part of the Cognition and Decision Lab group that I run with Hassan and Mark Dean. This coming summer, she will attend the Sloan-Nomis Summer School on Cognitive Foundations of Economic Behavior, to deepen her familiarity with psychological and neuroscientific approaches to modeling decision making.

Yeji's behavioral interests relate in particular to the search for alternatives to the full-information rational-expectations hypothesis as a model of the expectations underlying people's decisions, including (but not necessarily limited to) models of rational inattention and adaptive learning dynamics. Her current dissertation research proposes to develop the implications for both asset pricing and the volume of trade in asset markets of assuming that investors base their decisions on noisy memories of the data that they have observed in the past, rather than having access to perfectly precise information about all data that they have ever been able to observe, as is assumed both in standard rational-expectations models and in many prominent models of learning. In order to obtain a more parsimonious model, she is currently exploring the idea that the nature of the noisy memory is optimized (from within a very flexible class of potential information structures) so as to maximize the investor's welfare (on average, across a class of possible situations) subject to an information-theoretic constraint on the complexity of memory similar to the kind hypothesized to limit the precision of observations of external reality in the rational inattention theory of Sims.

The idea of endogenizing the structure of noisy memory in this way is proposed in a short paper of mine with Rava A. da Silveira that has just appeared in the *AEA Papers and Proceedings.* Yeji has been involved with this project from the beginning, initially as a research assistant (she is responsible for the numerical results shown in the *Papers and Proceedings* paper). She proved to be excellent in this capacity, and quickly became a full collaborator in the further development of this idea. She is currently taking the lead in further extending the work described in the *Papers and Proceedings* paper in several directions: (i) numerical analysis of the

dynamic evolution of the degree of precision of a decision maker's knowledge of the parameters of the true data generating process, if someone starts from an initial state of zero experience and then successively observes draws of the random state [a non-trivial problem, given non-convexity of the optimization problem, even in low-dimensional cases]; (ii) extension of the work reported in the *Papers and Proceedings* for the case of an i.i.d. income process to the problem of forecasting serially correlated processes [essential for quantitative comparison of the theory with empirical evidence, and a non-trivial extension, not merely because of the greater algebraic complexity, but because once the mean of past observations is no longer a sufficient statistic for the entire past history of observations, one must face the question of determining the optimal dimensionality of the noisy memory state, which differs depending on parameter values]; and (iii) numerical investigation of the degree to which a suitably parameterized version of the model can match quantitative features of various empirical and experimental datasets on reported forecasts [rather than discussing purely qualitative similarities, as in the *P&P* paper]. It is expected that Yeji will be a co-author on one or more papers resulting from these further developments of the research.

In addition, she is working on her own on developing the implications of a model of noisy memory along similar lines for asset pricing, as mentioned above. This involves several conceptual challenges, rather than being a direct application of the model proposed by Rava and me to a new dataset. First, it is necessary to derive an optimal memory structure for a problem in which the decision maker's preferences are different from the simple quadratic-utility case assumed in the *Papers and Proceedings* paper; a realistic model of asset pricing must involve preferences that make investors' decisions depend on perceived risk (or uncertainty about returns), rather than depending purely on the estimate of the mean of a random variable, as in the *P&P* paper. And second, in order to model the determination of asset prices and the volume of trade, one must model a general equilibrium in which many investors with different noisy memories interact, rather than an individual decision problem as in the *P&P* paper. These are substantial challenges, but her preliminary results indicate that she is able to tackle them. It is too soon to say how well her current modeling approach will succeed quantitatively, but it is at least clear that she will be able to produce a coherent model that addresses the issues that she seeks to investigate.

The work completed thus far on the projects described above has been primarily theoretical, albeit with a focus on computational methods that allow quantitative predictions to be derived for given parameter values. But her intention is certainly to address the fit of the models that she analyzes to data. As an indication that she definitely does not shy away from data analysis, I should perhaps mention that another of her projects (also not yet too far along) involves analysis of a large data set on the borrowing of individual Italian banks from the ECB on the one hand, and the lending of those banks to individual firms on the other; the goal of the project is to examine the effects of ECB lending policies on the availability of credit to firms. The fact that she has gotten access to these data (through Banca d'Italia) and has plunged into analyzing them indicates something about her degree of energy and entrepreneurialism, as well as the breadth of her interests.

Yeji is an extremely promising student, and while still at an early stage, her project on the effects of imperfect memory on asset markets has great potential. I strongly recommend her for a Behavioral Macroeconomics Dissertation Fellowship.

Sincerely,



Michael Woodford
John Bates Clark Professor
of Political Economy
Columbia University