Macroeconomic Analysis with Machine Learning and Big Data
Summer 2019
Last Update: July 2, 2019

Instructors: Weinan E and Yucheng Yang

Time: T, Th 9:00 - 12:00; F 10:00 - 12:00. Four weeks in July.

Location: Room 515, Lee Shau-kee Building (Teaching Building 2).

Office Hours: By appointment.

Description: We introduce emerging opportunities in macroeconomics due to the recent booming of big data and the development of machine learning. We will systematically discuss relevant existing work (e.g. state space models, heterogeneous agent models, reduced-form macro models) and a series of recent work. The course will be based on lecture notes by instructors and relevant papers.

Prerequisites: Calculus and Linear Algebra, at least one programming language. Students should also be familiar with at least one of the following courses at the advanced level: macroeconomics, statistics, machine learning. Not open to freshmen and sophomores.

Grading: 50% class participation and presentation. 50% final project. Auditing students are welcome, but should also participate in the in-class presentation.

Outline for the Course:

1. Overview:
   - 1.1 Introduction
   - 1.2 Basics of Machine Learning for Macroeconomics
2. Statistical Model in Macroeconomics and Machine Learning
   - 2.1 Vector Autoregressive Model and Structural VAR
   - 2.2 State Space Model, Filtering Problem and EM Algorithm
   - 2.3 Recurrent Neural Network and LSTM Network
   - 2.4 State Space Model with Non-standard Data
3. Structural Model in Macroeconomics and Machine Learning
   - 3.1 Representative Agent Model and DSGE
   - 3.2 Heterogeneous Agent Model: Krusell-Smith and variants
   - 3.3 Heterogeneous Agent Model in Continuous Time: HACT and HANK
   - 3.4 Solving High-dimensional Stochastic Control and PDEs using Deep Neural Networks
   - 3.5 Solving Structural Model using Deep Neural Networks
4. Empirical Macroeconomic Analysis with Big Data
   - 4.1 Credit & Consumption Data and the Great Recession
   - 4.2 Tax Data, Inequality and Economic Opportunity
   - 4.3 Scanner Data, Prices and Monetary Policy

4.4 Social Network Data, Economic Behavior and Macro Implications
4.5 Firm Data, ESIEC, Trade Data and Chinese Economy
4.6 Employer-Employee Data, Job Posting Data and Firm Dynamics
4.7 Alternative Data and New Measures of National Accounting
4.8 Textual Data, Uncertainty and Sentiments

In-Class Presentation The Friday lectures from the second week will be devoted to in-class student presentations on empirical papers using big data to address important macroeconomic questions. Each group could consist of 1-X students (depends on number of enrolled and audit students), and they would pick one core paper to present for 30 minutes (including Q&A).

The students should meet the instructor at least 3 days in advance (on or before Tuesday) to discuss the main idea they have learnt from the paper to make sure that they have got the key points. Besides presenting the core paper in detail, the students are encouraged to talk about other relevant papers the instructor has listed. Below are the topics and the core papers are marked with $*$.

Topic I: Credit & Consumption Data and the Great Recession

$*$ Mian, A., Rao, K. and Sufi, A., 2013. Household balance sheets, consumption, and the economic slump. *The Quarterly Journal of Economics*, 128(4), pp.1687-1726.

$*$ Mian, A.R. and Sufi, A., 2019. Credit Supply and Housing Speculation.

Mian, A. and Sufi, A., 2009. The consequences of mortgage credit expansion: Evidence from the US mortgage default crisis. *The Quarterly Journal of Economics*, 124(4), pp.1449-1496.

Mian, A. and Sufi, A., 2015. House of debt: How they (and you) caused the Great Recession, and how we can prevent it from happening again. University of Chicago Press.

Mian, A. and Sufi, A., 2018. Finance and business cycles: the credit-driven household demand channel. *Journal of Economic Perspectives*, 32(3), pp.31-58.

Baker, S.R., 2018. Debt and the response to household income shocks: Validation and application of linked financial account data. *Journal of Political Economy*, 126(4), pp.1504-1557.

Kueng, L., 2018. Excess sensitivity of high-income consumers. *The Quarterly Journal of Economics*, 133(4), pp.1693-1751.

Ganong, Peter, and Pascal Noel. 2019. Consumer Spending during Unemployment: Positive and Normative Implications. *American Economic Review*, 109 (7): 2383-2424.

Topic II: Tax Data, Inequality and Economic Opportunity

∗ Chetty, R., Hendren, N., Kline, P. and Saez, E., 2014. Where is the land of opportunity? The geography of intergenerational mobility in the United States. *The Quarterly Journal of Economics*, 129(4), pp.1553-1623.

∗ Saez, E. and Zucman, G., 2016. Wealth inequality in the United States since 1913: Evidence from capitalized income tax data. *The Quarterly Journal of Economics*, 131(2), pp.519-578.

∗ Piketty, T., Yang, L. and Zucman, G., 2019. Capital Accumulation, Private Property and Rising Inequality in China, 1978-2015. *American Economic Review*, 109 (7): 2469-96.

Chetty, R. and Hendren, N., 2018. The impacts of neighborhoods on intergenerational mobility I: Childhood exposure effects. *The Quarterly Journal of Economics*, 133(3), pp.1107-1162.

Chetty, R. and Hendren, N., 2018. The impacts of neighborhoods on intergenerational mobility II: County-level estimates. *The Quarterly Journal of Economics*, 133(3), pp.1163-1228.

Chetty, R., Friedman, J.N., Hendren, N., Jones, M.R. and Porter, S.R., 2018. The opportunity atlas: Mapping the childhood roots of social mobility.

∗ Fagereng, A., Guiso, L., Malacrino, D. and Pistaferri, L., 2019. Heterogeneity and persistence in returns to wealth.

∗ Fagereng, A., Holm, M.B. and Natvik, G.J.J., 2019. MPC heterogeneity and household balance sheets.

Fagereng, A., Holm, M.B., Moll, B. and Natvik, G.J.J., 2019. Saving Behavior Across the Wealth Distribution: The Importance of Capital Gains.

Topic III: Scanner Data, Prices and Monetary Policy

∗ Wong, Arlene, 2019. Refinancing and the Transmission of Monetary Policy to Consumption.

∗ Stroebel, J. and Vavra, J., 2019. House prices, local demand, and retail prices. *Journal of Political Economy*, Forthcoming.

DellaVigna, S. and Gentzkow, M., 2017. Uniform Pricing in US Retail Chains. *The Quarterly Journal of Economics*, Forthcoming.

Kaplan, G. and Schulhofer-Wohl, S., 2017. Inflation at the household level. *Journal of Monetary Economics*, 91, pp.19-38.

Hua, Amy, 2017. Learning the Structure of Price Stickiness in Scanner Data. Manuscript, Princeton University.

Cavallo, A., 2018. Scraped data and sticky prices. Review of Economics and Statistics, 100(1), pp.105-119.

Topic IV: Social Network Data and Macroeconomic Implications

∗ Bailey, M., Cao, R., Kuchler, T. and Stroebel, J., 2018. The economic effects of social networks: Evidence from the housing market. *Journal of Political Economy*, 126(6), pp.2224-2276.

∗ Bailey, M., Dvila, E., Kuchler, T. and Stroebel, J., 2019. House price beliefs and mortgage leverage choice. *The Review of Economic Studies*, Forthcoming.

Bailey, M., Cao, R., Kuchler, T., Stroebel, J. and Wong, A., 2018. Social connectedness: Measurement, determinants, and effects. *Journal of Economic Perspectives*, 32(3), pp.259-80.

Topic V: Firm Data and Macroeconomic Implications

∗ Dai, Ruochen, Mookherjee, D., Munshi, K. and Zhang, Xiaobo, 2019. The Community Origins of Private Enterprise in China.

∗ Shi, Yu, Townsend, R. and Zhu, Wu, 2019. Internal Capital Markets in Business Groups and the Propagation of Credit Supply Shocks.

Cong, L. W., Gao, H., Ponticelli, J. and Yang, X., 2019. Credit allocation under economic stimulus: Evidence from China. *The Review of Financial Studies*, Forthcoming.

∗ Autor, D.H., Dorn, D. and Hanson, G.H., 2013. The China syndrome: Local labor market effects of import competition in the United States. *American Economic Review*, 103(6), pp.2121-68.

Autor, D.H., Dorn, D. and Hanson, G.H., 2016. The China shock: Learning from labor-market adjustment to large changes in trade. *Annual Review of Economics*, 8, pp.205-240.

∗ Bernard, A.B., Dhyne, E., Magerman, G., Manova, K. and Moxnes, A., 2019. The origins of firm heterogeneity: a production network approach.

Topic VI: Employer-Employee Data, Job Posting Data and Firm Dynamics

∗ Song, J., Price, D.J., Guvenen, F., Bloom, N. and Von Wachter, T., 2018. Firming up inequality. *The Quarterly Journal of Economics*, 134(1), pp.1-50.

Card, D., Heining, J. and Kline, P., 2013. Workplace heterogeneity and the rise of West German wage inequality. *The Quarterly Journal of Economics*, 128(3), pp.967-1015.

∗ Davis, S.J., Faberman, R.J. and Haltiwanger, J.C., 2013. The establishment-level behavior of vacancies and hiring. *The Quarterly Journal of Economics*, 128(2), pp.581-622.

Liu, Yukun, 2019. Labor-based Asset Pricing.

Topic VII: Alternative Data and New Measures of Economic Indicators

∗ Jean, N., Burke, M., Xie, M., et al, 2016. Combining satellite imagery and machine learning to predict poverty. *Science*, 353(6301), 790-794.

∗ Blumenstock, J., Cadamuro, G., & On, R. 2015. Predicting poverty and wealth from mobile phone metadata. *Science*, 350(6264), 1073-1076.

Kreindler, G.E., Miyauchi, Y., 2019. Measuring Commuting and Economic Activity inside Cities with Cell Phone Records.

Glaeser, E.L., Kim, H. and Luca, M., 2017. Nowcasting the local economy: Using Yelp data to measure economic activity (No. w24010). National Bureau of Economic Research.

Yin, M., Sheehan, M., Feygin, S., Paiement, J.F. and Pozdnoukhov, A., 2017. A generative model of urban activities from cellular data. IEEE Transactions on Intelligent Transportation Systems, 19(6), pp.1682-1696.

Gebru, T., Krause, J., Wang, Y., Chen, D., Deng, J., Aiden, E.L. and Fei-Fei, L., 2017. Using deep learning and Google Street View to estimate the demographic makeup of neighborhoods across the United States. *Proceedings of the National Academy of Sciences*, 114(50), pp.13108-13113.

Chi, G., Liu, Y., Wu, Z. and Wu, H., 2015. Ghost cities analysis based on positioning data in China. arXiv preprint arXiv:1510.08505.

Clark, H., Pinkovskiy, M. and Sala-i-Martin, X., 2017. China's GDP growth may be understated (No. w23323). National Bureau of Economic Research.

Topic VIII: Textual Data, Uncertainty and Sentiments

Baker, S.R., Bloom, N. and Davis, S.J., 2016. Measuring economic policy uncertainty. *The quarterly journal of economics*, 131(4), pp.1593-1636.

∗ Atalay, E., Phongthiengtham, P., Sotelo, S. and Tannenbaum, D., 2019. The Evolution of Work in the United States. *American Economic Journal: Applied Economics*, Forthcoming.

Turrell, A., Speigner, B., Djumalieva, J., Copple, D. and Thurgood, J., 2018. Using job vacancies to understand the effects of labour market mismatch on UK output and productivity.

∗ Soo, C.K., 2018. Quantifying sentiment with news media across local housing markets. *The Review of Financial Studies*, 31(10), pp.3689-3719.

∗ Hassan, T.A., Hollander, S., van Lent, L. and Tahoun, A., 2019. Firm-level political risk: Measurement and effects.

∗ Jegadeesh, N. and Wu, D.A., 2017. Deciphering fedspeak: The information content of fomc meetings.

Kelly, B., Papanikolaou, D., Seru, A. and Taddy, M., 2018. Measuring technological innovation over the long run (No. w25266). National Bureau of Economic Research.

Gentzkow, M., Kelly, B.T. and Taddy, M., 2019. Text as Data. *Journal of Economic Literature*, Forthcoming.

Cong, L.W., Liang, T. and Zhang, X., 2019. Textual Factors: A Scalable, Interpretable, and Data-driven Approach to Analyzing Unstructured Information.

Final Project Students enrolled should submit a final project, which could either be a detailed 5-page proposal on a relevant original research, or a replication of one of the method papers covered in the class. Potential projects for original research would be discussed by the instructors in class. Students should meet the instructor to talk about the choice of the final project before the third week of class. The due time for the final project is 9 am July 31st.