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National Bureau of Economics Research
Cambridge, MA

October 28, 2019

Dear Sir/Madam,

I am writing to apply for a place on the Behavioral Macroeconomics Research Boot Camp. I am currently in my third year of the combined Masters/PhD programme in Economics at the University of Oxford. My research centers around Central Bank communication and how it shapes the expectations and beliefs of market participants and the general public.

I use Natural Language Processing techniques to extract the textual signals that Central Bank's send in their announcements, and use these signals to build and test theoretical models about the way in which expectations are formed in the macroeconomy. I believe that the Bootcamp will be a huge help to me in furthering my knowledge of the theoretical side of my research as it pertains to behavioural expectation formation.

I am supervised by Prof. Michael McMahon, who is my letter of recommendation writer. I enclose my CV and a two page essay documenting my rationale for attending the Bootcamp.

Yours faithfully,

Timothy Munday

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Nuffield College, 1 New Road, Oxford, OX1 1NF, UK

Education

2017 - 2022 PhD (inc. Masters Degree) in Economics, **University of Oxford**
Research agenda: Central Bank Communication | Advisor: Prof. Michael McMahon
Ranked overall second in First year PhD exams out of 70 students
Ranked 1st in First Year PhD Microeconomics exams

Courses taken in 2017 (first year PhD):
Macroeconomics | Textbook: Romer, Advanced Macroeconomics; Woodford, Interest and Prices
Topics: Growth, business cycles, new keynesian monetary theory, monetary and fiscal policy
Microeconomics | Textbook: Mas-Colell, Whinston, Greene, Microeconomic Theory
Topics: Consumer and producer theory, General equilibrium, IO, game theory, auctions, welfare
Econometrics | Textbook: Custom notes
Topics: ML, GMM, time series, panel data, asymptotic theory

Courses taken in 2018 (second year PhD):
Advanced Macroeconomics 1 | Textbook: Evans and Honkapohja, Learning and Expectations in Macro...
Topics: Indeterminacy, limit cycles, learning, SRAs, bayesian ratioanl expectations
Advanced Macroeconomics 2 | Textbook: Custom notes
Topics: DSGE solution methods, estimation, bayesian estimation, monetary policy identification
Advanced Econometrics 1 | Textbook: Custom notes
Topics: Markov switching models, dynamic panel regressions, non-parametric methods
Financial Economics 1 | Textbook: Custom notes
Topics: Asset pricing, market microstructure
International Macroeconomics and Finance | Textbook: Custom notes
Topics: Replication of open economy DSGE models in DYNARE

2012 - 2015 Bachelor of Arts in Economics, **University of Cambridge**
Double first | Ranked 3rd out of 170 students
Thesis: "An Investigation into the Effect of Sports Matches on Investor Sentiment and Stock Market Returns" | Advisor: Dr. Povilas Lastauskas

Employment

2019 - 2020 Visiting Academic, **Bank of England**
2019 - 2019 PhD Intern, **Bank of England**
2018 - 2019 Research Assistant and Software Developer, **Econ-Ark** | Manager: Prof. Chris Carrol
2018 - 2018 Summer Researcher, Open Source Macroeconomics Lab, **University of Chicago**
2015 - 2017 Economist, **Goldman Sachs**, London | Manager: Huw Pill
Produced high quality written economic research on a variety of topics
Developed statistical models to forecast European wage growth
Wrote the Goldman Sachs Annual European Economic Outlook

Selected Research

In Progress — Central Bank Communication and Higher Moments
I ask how central bank communication affects the second and third moments of the public's perceived distribution of future policy rates
This paper demonstrates evidence in support of Morris and Shin's (2002) model of communication and uncertainty

In Progress — The Transmission of Central Bank Communication to the General Public
This paper uses Natural Language Processing to map the transmission of communication to the news cycle

Nov 2016 — Europe's outlook: A fiscal fillip sustains the modest recovery, *Goldman Sachs*
Solely responsible for producing the annual Goldman Sachs European macroeconomic outlook.
Analysed the support afforded to Euro area growth from easier fiscal policy and labour reforms.
Flagged and discussed upcoming political risks such as the French elections.
Included a variant scenario analysis on our forecasts using a DSGE model.

Oct 2016 — Incorporating the long term unemployed into the NAIRU, *Goldman Sachs*
Developed a state-space model to estimate the NAIRU as a latent variable.
Adjusted for the fact that the long term unemployed exhibit less pressure on wage formation.
Found that slack is materially larger in the Euro area when calculating a duration-weighted NAIRU.

Sept 2016 — Norway – Hot inflation in a cold climate, *Goldman Sachs*
Used an error correction model to estimate the currency pass-through to Norwegian inflation.
Calculated that 2/3rds of the rise in inflation since 2013 can be accounted for by a weaker Krone.

Aug 2016 — Inflation expectations - Demographics matter, but only in the long run, *Goldman Sachs*
Used individual survey level data on inflation expectations in the UK.
Deduced that cohorts that have lived through higher inflation report higher inflation expectations.
As these cohorts drop out of survey samples, inflation expectations are likely to grind lower.

May 2016 — Lifting the lid on Euro area wage growth, *Goldman Sachs*
Used a vector autoregression to decompose wage growth in the Euro area.
Found that significant slack and a persistently low inflation are weighing on wage dynamics.

May 2016 — Euro area labour markets – A little less segmentation, a little more interaction, please, *Goldman Sachs*
Analysed the responsiveness of unemployment in French regions to innovations in neighbouring regions.
Examined this relationship across both regional and national borders.
Used regions that were adjacent to certain regions but not others as exogenous regressors to perform Two Stage Least Squares within a regression discontinuity framework.
Found that regional unemployment is far more responsive to developments in adjacent domestic labour markets, as opposed to adjacent labour markets that cross international borders.
This is despite the despite freedom of movement of labour within the Euro area.

Mar 2016 — Structural and cyclical developments in Euro area labour markets, *Goldman Sachs*
Examined shifts in the Beveridge curves of Euro area countries.
Used a panel regression to ascertain that the duration of unemployment benefits has acted to depress labour market efficiency in peripheral European labour markets.

Dec 2015 — Why did Europe experience uneven growth after the financial crisis?, *World Economic Forum*
Also published as: Accounting for differences in Europe's post-Crisis growth, *VoxEU*
Decomposed Euro area growth into contributions from labour, capital and TFP via a production function.
Weak labour utilisation revealed to be behind lacklustre Euro area growth performance following the Global Financial Crisis.

Scholarships and Awards

June 2019	Jerry Hausman Scholarship | Two years of full postgraduate funding
June 2019	George Webb Medley Prize (proxime accessit) | Awarded for second place in MPhil exams
July 2018	Open Source Macroeconomics studentship worth $4200
Sept 2017	ESRC Grand Union DTP funded studentship | Four years of full postgraduate funding
June 2015	Schuldham Plate | Awarded to the top graduating student in the college
June 2015	Evanthia Sofianou Prize | Awarded to the top final year economist in the college
June 2014	Senior Scholarship | Awarded for first class marks in second year exams
June 2013	Scholarship | Awarded for first class marks in first year exams
June 2013	Stanley Denison Prize | Awarded to the top first year economist in the college

Computer Skills

Advanced Knowledge:	Python: I use python for most of my analytical work. I mainly work with the gensim library for text analysis and scikit-learn for machine learning.
Working Knowledge:	Matlab, R, Stata

Behavioural Macroeconomics Research Boot Camp — Essay

Tim Munday

I want to attend the Behavioural Macroeconomics Research Bootcamp for three reasons: (i) to better understand behavioural aspects of expectation formation from a theoretical perspective, (ii) to use these theoretical insights to improve the structural modelling components of my current research papers, and (iii) to gather ideas and explore the frontier of behavioural Macro research in preparation for starting my job market paper.

I will (very) briefly descirbe the first two chapters of my PhD thesis, and how the Bootcamp could significantly improve their quality (points (i) and (ii)). I will then move on to my aspirations on the job market and the benefits of the Bootcamp for that (point (iii)).

My current research centres around the role of Central Bank communication in shaping the beliefs and expectations of financial markets and the general public.

In the first chapter of my PhD thesis, I investigate the role that Bank of England communication plays in influencing the variance and skew of expected future interest rates, as measured in option markets. The paper made two contributions to the literature. First, it demonstrated, using Natural Language Processing techniques to reduce the dimensionality of the text released by the Bank of England, that their communication is relevant for explaining the variation in the second and third moments of market-expectations, even if there was no monetary policy announcement on the day of the communication. Secondly, it provided empirical evidence for Morris and Shin (2002)'s theoretical model of Central Bank communication, in which under certain circumstances Central Banks prefer to release more ambiguous signals about the economy.

However, my first paper could benefit greatly from the Bootcamp. The support the paper demonstrates for Morris and Shin (2002) is only convincing during the financial crisis period. In my paper, I explain this by letting some of the Morris and Shin parameters vary over time. However, a much more satisfying exercise would be to allow the state of the economy about which the Central Bank is signalling to change how ambiguous the Central Bank wants to be, and the extent to which agents pay attention as in Pagel (2018). This is a much larger theoretical undertaking, and requires a deeper understanding of signal processing and behavioural expectation formation literature than I currently have. I hope to interrogate this idea and explore its validity at the Bootcamp.

My second paper, which is at an earlier stage, is a far more technical exercise. I use word embeddings and other state-of-the-art techniques from machine learning to map the transmission

from Central Bank communication to articles in the news that cover the Central Bank. Whilst the empirical exercise in this paper is novel, it is lacking a grounding in the modelling of both how newspapers choose to report Central Bank communications (Gentzkow and Shapiro (2010) or Nimark (2014)), or a model of how consumers take in information about the Central Bank, of which there has been some interesting survey evidence (Coibion, Gorodnichenko, and Weber (2019) and Lamla and Vinogradov (2019)). I hope that the Bootcamp will deepen my understanding of these issues, particularly how agents process signals in a behavioural setting — many presenters at the Bootcamp have worked on this, but one example is Caplin and Leahy (2004) — allowing me to complete this paper and make a meaningful contribution to the Central Bank communication literature.

Finally, I want to attend the Bootcamp to explore ideas for my job market paper. My research, whilst currently focused on Central Bank communication, is fundamentally about expectation formation. Behavioural macroeconomics is the field which has the most to say about expectation formation as it pertains to applications in the real world — including for Central Bank decisions. I believe the Bootcamp would be an ideal arena for me to probe ideas for a job market paper situated in the nexus between behavioural expectation formation, Central Bank signalling, and Natural Language Processing.

Insofar as the three reasons elucidated in the introduction can be drawn together into one argument, they demonstrate a desire to become a more rounded economist. Currently I believe myself to be well trained in computational and technical aspects of my field. I have completed a six week python bootcamp at the University of Chicago, worked as a software developer for Chris Carrol's heterogenous agent solving module in python (Econ-Ark), worked as a data scientist at the Bank of England (where I am now a visiting academic in the Advanced Analytics team), and spent two years forecasting European economies at Goldman Sachs using a variety of time series econometric models. However, if I am to succeed as a successful *academic* economist, I must flesh out the structural and theoretical side of my work. Since my work concerns expectation formation, I cannot think of a better place to learn, grow and grasp new methods than at the Behavioural Macroeconomic Research Bootcamp.

References

Caplin, Andrew and John Leahy (2004). "The supply of information by a concerned expert". In: *The Economic Journal* 114.497, pp. 487–505.

Coibion, Olivier, Yuriy Gorodnichenko, and Michael Weber (2019). *Monetary policy communications and their effects on household inflation expectations*. Tech. rep. National Bureau of Economic Research.

Gentzkow, Matthew and Jesse M Shapiro (2010). "What drives media slant? Evidence from US daily newspapers". In: *Econometrica* 78.1, pp. 35–71.

Lamla, Michael J and Dmitri V Vinogradov (2019). "Central bank announcements: Big news for little people?" In: *Journal of Monetary Economics*.

Morris, Stephen and Hyun Song Shin (2002). "Social value of public information". In: *American Economic Review* 92.5, pp. 1521–1534.

Nimark, Kristoffer P (2014). "Man-bites-dog business cycles". In: *American Economic Review* 104.8, pp. 2320–67.

Pagel, Michaela (2018). "A News-Utility Theory for Inattention and Delegation in Portfolio Choice". In: *Econometrica* 86.2, pp. 491–522.

Date: 19 November 2019

To Whom It May Concern,

Re: Tim Munday's application for Behavioral Macroeconomics Research Boot Camp

I have been asked to submit on behalf of a current student of mine in the DPhil (PhD) at Oxford, **Tim Munday**, a reference for his application for the Behavioral Macroeconomics Research Boot Camp. I would like to try to accurately reflect his ability through his performance at Oxford.

I teach both undergraduates and postgraduate students at Oxford, as I did previously in Warwick. I have also previously taught on the graduate course in the economics department at LSE, and I was a visiting assistant professor in the economics department at Stanford University. I therefore feel I am in a good position to judge Tim's excellent ability and suitability for this course.

Put simply, I cannot recommend Tim highly enough and I believe that he would be a wonderful and successful participant in the course. I taught him MPhil Macroeconomics and so he is well-versed in the full technical details of core macroeconomic models of Economic Growth and Business Cycles. This includes solution techniques for macroeconomic models including perturbation techniques such as log-linear approximations, as well global solution methods. He progressed very well through the course and has been selected as a Nuffield College graduate student which is the most prestigious of the college scholarships that are available at this stage of his studies.

His research so far, though Tim is only in the first year of the research component of the DPhil (US 3rd year), has examined issues related to expectation formation and central bank communication. This includes looking at distributions of expected distribution of policy rates and especially whether communication shifts the second or third moments of expectations about future policy decisions. This work is mostly empirical but has a specific test of the Morris and Shin idea that central bank communication might coordinate expectations.

I am very happy to supervise him on the DPhil. His work on his DPhil Dissertation so far has been very encouraging. He has the technical and computational skills for the research in the area of measuring the impact of communication. His background in Goldman Sachs also gives him an important perspective on the research topic.

Most papers about the effects of central bank communication are, ultimately, about expectations formation. Given the relevance of behavioural economics to discussions of expectations formation, it could be argued that students of central bank communication who do not engage with behavioural economics are essentially neglecting a key part of the potential channels through which central bank communication has important macroeconomic

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effects. Tim is not such a student. He is pursuing a broad approach to studying the effects of communication by drawing on existing literatures in macroeconomics and other fields. When he alerted me to his desire to take part in the NBER course, and the content of the course, I did not need convincing that this was a course that is appropriate for, and beneficial to, Tim's studies.

Tim is well-trained technically – he finished the MPhil (PhD coursework component) last year with the top marks in microeconomics as well as top marks in other subjects. Tim is also very proficient in Python programming. Tim is, moreover, a very nice and engaging student. I have no doubt that he would be a pleasure to include in the course and that he would benefit greatly from the experience.

I hope that this information proves useful. Should you require any further information then please feel free to contact me by email on michael.mcmahon@economics.ox.ac.uk.

Yours sincerely,



Michael McMahon
Professor of Economics