

Research Statement

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I. Overview

I am a macroeconomist with a research focus on nonlinear business cycle dynamics. In particular, my work studies on the speed and duration of economic recoveries and the responses of macroeconomic conditions to different policy actions.

The first stream of my research is methodological and focused on identifying and estimating the unobserved cyclical components of output that define the state of the economy. Recessions and expansions are cyclical phenomena; consequently, policy actions intended to mitigate the effects of downturns primarily target cyclical movements in macroeconomic aggregates. Correctly identifying cyclical and trend movements is therefore crucially important for designing policy. In the second stream of my research, I study the nonlinear effects of demand shocks on aggregate economic activity.

Trend Cycle Decomposition and Business Cycle Methodology

The first stream of my research is focused on the intersection between econometric trend-cycle decompositions and identifying the drivers behind recessions and recoveries. In my paper **“Decomposing the Output Gap with Inflation Learning”** (2022, *Journal of Economic Dynamics and Control*), coauthored with Srikanth Ramamurthy, we augment the commonly used unobserved components trend-cycle decomposition method for output with a formal theoretical component and an adaptive learning process for inflation expectations. We study if augmenting the model to account for imperfect learning about inflation can help improve inference about the output gap, and we find that our model improves inflation forecasts and inference about the output gap. In a related working paper **“Estimated Output Gap in a Wage-Inflation Expectations Model”** (2024, *working paper*) coauthored with my PhD students Prajyna Barua Soni and Azharul Islam and with Srikanth Ramamurthy, we allow for bivariate feedback in the learning dynamics for wage and price inflation and augment the model with two Neo Keynesian Phillips Curves. While wage inflation explains a small share of overall inflation, allowing for this bidirectional learning process in the expectations significantly improves both the fit and the predictive performance. Furthermore, when allowing for bidirectional feedback, we find that the perceived persistence of inflation fell during the early stages of the pandemic and it increased sharply during the 2021-2023 period.

In **“Recession-specific Recoveries: “L’s, U’s and Everything in Between”** (2021, *Economics Letters*) with Luigi Donayre we develop a new empirical model that allows for recession-specific recoveries where some recessions and recoveries cause permanent shifts in the economy and some only cause temporary disruptions with a full recovery. We model output growth as the weighted average of Markov-switching processes that temporarily alter the level of real GDP and those with permanent effects, where the recession-specific weight for each model is endogenously estimated. The majority U.S. recessions reflect a weighted combination of the two shapes, suggesting multiple sources of recessions. Consequently, models that imply only one possible path for a given recession may be insufficient to fully characterize the behavior of output during recessionary periods. This project is closely related to my previous work on slow recoveries in labor markets,

and to a new project with Luiggi Donayre “**The Speed of State-Level Recoveries**” (2024, **working paper**) where we build on our initial work to study recoveries at the state level. We find significant heterogeneity both in the speed and the duration of recessions and recoveries at the state level, and both are informative when trying to capture the dynamics of the macroeconomy at the aggregate level.

This stream of my research is related to several of my other recently published works and works in progress. In “**Is Business Cycle Asymmetry Intrinsic in Industrialized Economies?**” (2020, *Macroeconomic Dynamics*), coauthored with James Morley, we use trend-cycle decompositions to answer an empirical question about business cycle nonlinearity in industrialized economies. In particular, we consider a modification of the model-averaged forecast-based estimate of the output gap to measure economic slack for ten industrialized economies. By accounting for model uncertainty our measure is robust to different assumptions about the underlying structure of the economy. Our modelling approach can be used to reliably extract estimates of the output cycle, is computationally simple, and can be very easily extended to estimate output cycles for economies that have shorter data samples. In “**Business Cycle Synchronization and Asymmetry in the Eurozone**” (2024, **Working Paper in the Revise and Resubmit Stage, funded by the Croatian Academy of Sciences Grant IP-2019-04-4500 and MacroHub Project 6785, 7031**) with Vladimir Arcabic and Josip Tica we extend this idea within the context of international business cycle synchronization. This is particularly salient within the context of the European Monetary Union: if countries have business cycles with different amplitudes or different phases, a policy action that may help one member can be detrimental to another member. We show that different assumptions about the output cycle can lead to very different implications when it comes to business cycle synchronization in the European Union. While both core and periphery countries experience nonlinear recessions and recoveries, the nature of nonlinearity is quite different across countries, which indicates that there is no “one size fits all monetary policy”.

On the econometric side, in our paper “**Testing Stationarity with Unobserved Components Models**” (2017, *Macroeconomic Dynamics*) coauthored with James Morley and Tara Sinclair, we developed a new test for stationarity that can be used in cases when a variable has a stochastic trend and feedback between the trend and the cycle. We propose the use of a likelihood ratio test of stationarity based directly on the unobserved components models used in estimation of stochastic trends, meaning that our test is very straightforward to implement in empirical macroeconomic research to test for the presence of a stochastic trend component.

Economic Recoveries and Policy

In my early work, “**What Explains the Recent Jobless Recoveries**” (2017, *Macroeconomic Dynamics*), I analyzed how the nature of recoveries in the US labor market has changed over time. The slow “jobless” labor market recovery was one of the primary concerns when it came to policy normalization in the aftermath of the Financial Crisis. When this paper was published, it was the first study at the time that jointly considered the link between the trends and the cycles in output, employment, and hours as potential explanation for jobless recoveries. I found significant evidence in favor of a change in the relationship between the cyclical components of output and labor market variables, supported by the fact that employment is more sensitive to demand shocks post-1984. This has important potential implications for policy because it indicates that

there have been structural changes in the nature of the business cycle. This project is related to two follow up students coauthored with my PhD students. **“A Look at Jobless Recoveries in G7 Countries”**, coauthored with my former PhD student Ahmed Elroukh and with Alex Nikolsko-Rzhevskyy (2020, *Journal of Macroeconomics*) is a continuation of this research stream. Using both revised and real-time data, we consider several popular measures of the output cycle to study how the nature of employment growth in G7 countries has changed over time. Our results show that jobless recoveries are a global phenomenon. However, we also find evidence in favor of heterogeneity across countries, both in the responses of employment growth to cyclical movements in employment and in the responses of employment to the output cycle.

In **“Jobless Recoveries and Time Variation in Labor Markets”**, coauthored with my former PhD student Licheng Zhang (2024, *working paper in the Revise and Resubmit Stage*), we explore this topic from a different angle. We study whether the breakdown in the relationship between the employment cycle and the output cycle is restricted to limited periods or stages of the business cycle, or whether it is a more systemic gradual process. The previous literature, including my own work, has used more restrictive models that focus on select stages of the business cycle and on one or two variables of interest such as payroll employment or hours. In this paper we use a flexible time-varying-parameter model to explore how the relationship between output and a large set of labor market inputs has changed over time. We find that the responses of overall employment and unemployment to GDP became abruptly weaker. However, the responses on the intensive margin and the responses of part-time employment and employment in specific sectors became gradually stronger. A particularly interesting implication of this gradual evolution is that it implies uneven changes in the nature of the business cycle across sectors.

There is a complex relationship between the nature of economic recoveries and the efficacy of policy. The changing nature of economic recoveries can affect the efficacy of policy, and economic policy can hinder or accelerate the speed of economic recoveries. In my early work **“State-Dependent Effects of Fiscal Policy”** (2015, *Studies in Nonlinear Dynamics and Econometrics*), coauthored with James Morley and Steven Fazzari, we studied whether the impact of an increase in fiscal spending is different depending on the time when the increase was implemented and its efficiency across recessions, recoveries, and mature expansions. Our model differed from the related literature in three important ways. First, we found that capacity utilization is more economically relevant than a simple binary dummy variable for recessions. Second, we allowed for the possibility that there could be asymmetries in the middle of the business cycle. We find that when the threshold is estimated, rather than imposed, the US is in the high-impact state about 60% of the time, more often than just in recessions, indicating that policy changes implemented in lackluster recoveries could be effective. Third, we introduced a comparison method for the posterior distribution of the impulse responses, which allowed us to directly evaluate whether there is evidence of state-dependence for any two given initial states. This paper received an Institute for New Economic Thinking grant (IN01100009) and an Australian Research Council grant (DP130102950). In our related study **“When is Discretionary Fiscal Policy Effective”** (2021, *Studies in Nonlinear Dynamics and Econometrics*), we jointly evaluated whether spending and tax changes have nonlinear effects, and whether the effects of austerity measures are different in magnitude from the effects of stimulus measures. This related project was also funded by the same ARC grant (DP130102950),

and presented at the Australian Treasury in 2017. The fiscal response to the COVID crisis in 2020 in Australia reflected a recently revised view at the Treasury of the effectiveness of policy that is more consistent with our findings.

In “**State-Dependent Exchange Rate Pass-Through Behavior**”, with Luigi Donayre (2016, *Journal of International Money and Finance*) we also focused on the state-dependent transmission of demand shocks but through an international lens. We studied the effects of nonlinear demand shocks on prices through the exchange rate pass-through channel, and we find that the pass-through is higher in expansions. This project is linked to my other projects in two ways. First, we evaluate whether prices respond differently to demand shocks across different stages of the business cycle, with exchange rate shocks being a specific example of a demand shock. More broadly, the paper is linked to the nonlinear policy literature because the pass-through directly determines the degree of independence when designing monetary policy at different stages of the business cycle.

Recent Interdisciplinary Work

Two of my recent interdisciplinary papers incorporate a combination of conventional macro econometric methods and machine learning approaches applied to economics and finance. In McInnish, Nikolsko-Rzhevskyy, Nikolsko-Rzhevskaya, and Panovska (2020, *Financial Management*), coauthored with coauthors from the economics and finance department at Lehigh University and the University of Memphis, I compared conventional nonlinear models to new machine learning models in financial markets. In Dey et al. (2020, *PhysicaA*), coauthored with collaborators from the Statistics Department at UT Dallas, Lamar University, and the University of Louisiana at Lafayette, I incorporated the nonlinear models I have developed in previous work and a machine learning approach based on a large data set and a graph theory model from statistical theory to predict outcomes in macroeconomic and financial variables.

Selected Research in Progress

My current work in progress lies at the intersection of my two research streams and focuses on modelling economic recoveries. In my ongoing work with Luigi Donayre “**State Level Recoveries**”, we study how the speed of recoveries in US states has changed over time, and how aggregation affects the estimates at the national level. Our 2021 publication estimated the basic model, the follow up project estimates the time-varying disaggregated model. Our findings indicate that there is a significant amount of heterogeneity both across recessions and across states. This is a multi-paper project, and our next steps entail exploring the determinants of the speed of recoveries. In “**Jobless Recoveries and Time Variation in Labor Markets**”, coauthored with my former PhD student Licheng Zhang (2024, working paper in the Revise and Resubmit stage), we study whether the breakdown in the relationship between the employment cycle and the output cycle is restricted to limited periods or stages of the business cycle, or whether it is a more systemic gradual process that is not limited only to the recovery stage. We find that while there has been a sharp decline in the relationship between output and the extensive margin, the link between output and the intensive margin has become stronger over time, and this pattern is not restricted to the recession or the recovery stage.

In **“Estimated Output Gap in a Wage-Inflation Expectations Model” (2024, working paper)** coauthored with my PhD students Prajyna Barua Soni and Azharul Islam and with Srikanth Ramamurthy, we extend a statistical trend-cycle decomposition with a theoretically motivated bivariate learning process based on a New Keynesian Phillips curve to allow for bivariate feedback in the learning dynamics for wage and price inflation and an adaptive learning process where agents form their inflation expectations slowly. Three interesting sets of results stand out. First, while the perceived persistence of inflation fell during the early stages of the pandemic, it increased sharply and substantially during the period 2021Q2-2022Q2. Second, the estimated output gap started decreasing in mid-2019, indicating economic softening prior to the COVID crisis and decreased sharply during the early stages of the pandemic. However, we find that a non-trivial share of the decline in output during the pandemic can be explained by a drop in the trend, indicating that permanent changes are also important for explaining the dynamics following the COVID recession. Finally, we find that including information about the output gap and about the price and wage inflation expectations process helps improve macroeconomic forecast

My future work will continue to focus on nonlinear models of the business cycle, both using quasi-structural models and by leveraging new approaches in machine learning such as alternative model averaging schemes that allow us to account for model uncertainty.