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Research Statement

My current research is on monetary economics, international economics, and productivity growth.

My work has primarily focused on the interaction of business-cycle stabilization policies and the macroeconomy. An overarching theme in my research is to study scenarios where traditional policy levers may be constrained (as in the lower bound on nominal interest rates in the United States), identify novel channels for policy transmission, and ultimately how a policy may be designed to improve business-cycle stabilization. I have theoretically and empirically examined the possibility of persistent effects of transitory business cycle shocks, developed theoretical insights on the emergence of safe asset scarcity, and analyzed the usefulness of modeling behavioral expectations in a new Keynesian framework.

My research has been published or accepted in the Review of Economic Studies, the Journal of Monetary Economics, the Review of Economics and Statistics, the Journal of Economic Dynamics and Control, the IMF Economic Review, and the India Policy Forum. Most of these papers were published or accepted after I joined the University of California Davis, in Fall 2017.

Hysteresis: Persistent Effects of Transitory Shocks

The first theme in my research is about studying macro policies in a hysteresis-prone environment, i.e., settings when temporary shocks may have a persistent effect on the economic output. The response of macroeconomic variables following these shocks then resembles a frying pan.[1] I ask whether such policy skillets exist in the real world, and if policy makers could and should deliver healthier economic outcomes.

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[1] Krugman, P.R. 2023. Out of the frying pan, into a lost decade. NYT newsletter Aug 1, 2023.

The paper, *Output Hysteresis and Optimal Monetary Policy*, is joint with Vaishali Garga of Boston Fed, and was published in the *Journal of Monetary Economics*. We incorporate endogenous productivity growth into a new Keynesian framework and study optimal monetary policy.

We show that a standard monetary policy rule (Taylor rule) admits permanent output gaps (output hysteresis) following temporary contractions in aggregate demand. Incomplete stabilization of aggregate demand reduces incentives to undertake productivity enhancing investment. A lack of demand may thus distort supply over time. Policy rules such as strict inflation targeting can insulate the economy from these long-run effects. However, at the zero-lower-bound (ZLB), strict inflation targeting rules are unable to stabilize aggregate demand and admit output hysteresis. Optimal policy at the ZLB involves offsetting these hysteresis effects by credibly promising lower interest rates upon exit from ZLB. Such a policy, however, is dynamically inconsistent - a policymaker unable to commit to future actions is biased towards large output gaps relative to commitment policy. We label this as the hysteresis bias of discretionary policy. Our framework micro-founds one possible origin of output hysteresis as the absence of credibility tools for the central bank. A methodological contribution of this paper was to derive a purely quadratic welfare objective for the central bank in an endogenous growth environment. Growth considerations emerge as an objective in the social welfare criterion.

The paper, *The Long-run Effects of Monetary Policy*, is joint with Òscar Jordà of UC Davis and Alan M Taylor of UC Davis, is unpublished but has been presented at several conferences and seminars since early 2019. Using various identification strategies, we document that monetary policy shocks have more persistent effects on the real economy activity than has been documented in the literature. Our main emphasis is on estimating dynamic impulse responses to a monetary shock identified with the "trilemma" instrument (Jordà, Schularick & Taylor, 2020).[2] In response to an exogenous monetary shock, we find that output declines and is *persistently* lower relative to its pre-shock trend. This gap persists at least twelve years out. We find that capital stock and total factor productivity (measured as a Solow residual) also exhibit these persistent effects. Labor, on the other hand, falls after a contractionary shock, but returns to the pre-shock trend twelve years

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[2] Jordà Ò., M. Schularick, and A. M. Taylor. 2020. The Effects of Quasi-random Monetary Experiments. Journal of Monetary Economics.

later. Interestingly, we find there is a sign asymmetry: these persistent effects are at play after contractionary shocks, but not after easing monetary shocks. The persistence result documented in this paper stands in contrast to the overwhelming consensus in the literature that monetary shocks, at best, have a short-run effect on output.

The paper, *Supply or Demand? Policymakers' Confusion in the Presence of Hysteresis,* is joint with Antonio Fatás of INSEAD. We revised and re-submitted the paper to the *European Economic Review*. We study the case of a central bank that ignores the presence of hysteresis when setting policy. The central bank designs optimal monetary policy under the assumption that the persistence in the GDP is a result of permanent exogenous shocks to total factor. In the correct model, the persistence is an outcome of hysteresis. Demand-driven fluctuations lead, through hysteresis, to permanent changes in output. We show that in this environment, the central bank is not aggressive enough and its actions generate dynamics of GDP that are consistent with the mistaken beliefs. Output is as persistent as the central bank had assumed but the persistence is entirely due to the mistaken policy that it had implemented. Not only the mistakes are costly, but they might never get corrected because the actual behavior of GDP resembles the policymaker's forecasts from a mistaken model. Policymakers who believe that persistence is caused by supply shocks will continue believing in their assumptions. Suboptimal policy regimes self-perpetuate.

The paper, *Longer-run Economic Consequences of Pandemics*, is joint with Òscar Jordà of UC Davis and Alan M Taylor of UC Davis, was published in the *Review of Economics and Statistics*. We study major pandemics using the rates of return on assets stretching back to the 14th century. We find that real rates of return in the aftermath of pandemics are persistently depressed, in stark contrast to what happens after wars. We show that these findings are qualitatively consistent with the neoclassical growth model: capital is destroyed in wars, but not in pandemics; pandemics instead may induce relative labor scarcity and/or a shift to greater precautionary savings. We wrote two general interest summary articles based on this research, which were published at IMF's *Finance and Development* magazine and in a CEPR VOXEU column respectively.

In addition to these papers on hysteresis, I am working on a paper titled "The Distribution of Market Power and Monetary Policy" with Yumeng Gu, who just completed her PhD at UC Davis.

This paper extends the Keynesian growth framework of Benigno and Fornaro (2018)[3] to allow incumbents to innovate and gain market power following Peters (2020).[4] Successful innovation by entrants results in displacement of existing firms and disrupts the accumulation of market power by the incumbents. A cross-sectional distribution of markups endogenously responds to business cycle shocks through variations in entrant innovation. A contractionary monetary policy shock reduces the incentives for potential entrants to innovate. If existing firms continue their innovation, unaffected by temporary business cycle shocks, they accumulate higher market power with successful innovation. Thus, a monetary policy induced recession reduces the incentives for potential entrants to innovate, reduces allocative efficiency across firms, and leads to an endogenous slowdown in TFP growth. Yumeng presented an early version of this paper at the SED meeting in 2021 and the North American Summer Meeting of the Econometric Society in 2021.

Diagnostic Expectations in the New Keynesian Model

The paper, *Incorporating Diagnostic Expectation into the New Keynesian Framework*, is joint with Jean-Paul L'Huillier of Brandeis University and the Cleveland Fed, and Donghoon Yoo of Academia Sinica. It has been accepted for publication in the *Review of Economic Studies.* This paper contributes to understanding how various behavioral departures from full-information rational expectations (FIRE) paradigm affect our understanding of the macroeconomy. Diagnostic expectations, pioneered in several papers by Pedro Bordalo, Nicola Gennaioli and Andrei Shleifer, have emerged as one of the important departures from FIRE. These expectations are a form of extrapolative expectations whereby agents extrapolate from current news to make inference about the future states of the world.

In this paper, we make three contributions: methodological, analytical, and empirical. Methodologically, we show how to solve linear dynamic general equilibrium models with diagnostic expectations. Analytically and empirically, we argue that incorporating diagnostic expectations to the new Keynesian (NK) toolkit is a productive endeavor. Modeling agents' expectations ala diagnostic expectations brings forth new insights. Analytically, we show that these expectations interact with price rigidity frictions in the NK environment to generate excess

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[3] Benigno, G., and L. Fornaro. 2018. Stagnation Traps. The Review of Economic Studies.
[4] Peters, M. 2020. Heterogeneous mark-ups, growth and endogenous misallocation. Econometrica.

volatility, supply-side disruptions as Covid-19 can generate Keynesian recessions when agents are diagnostic, and government spending multipliers can be large even away from the zero lower bound. Empirically, we show that diagnostic expectations, by virtue of being an endogenous mechanism to generate errors in expectations, outcompete news shocks in estimated medium scale DSGE models disciplined using survey forecast data.

Safe Asset Scarcity and Zero Lower Bound

The paper, *Bond Premium Cyclicality and Liquidity Traps*, is joint with Nicolas Caramp of UC Davis. It has been published in the *Review of Economic Studies*. We develop a theory of the macroeconomic consequences of safe asset scarcity. With conventional monetary policy constrained by the zero-lower bound on the short-term nominal interest rate, an important body of literature advocated for an increase in the supply of (safe) U.S. government bonds to compensate for the private safe asset shortage. In this paper, we show that this policy prescription may not be robust. Whether issuances of public safe assets are expansionary or not depends on the nature of the shock that hit the economy and the cyclical properties of asset prices. Our theory puts at the forefront the bond premium; that is, the premium households pay to hold assets that provide non-pecuniary benefits.

The main theoretical result of the paper shows that when the bond premium is counter-cyclical, that is, there is a negative correlation between the bond premium and changes in aggregate output, the economy admits two steady-state equilibria.

One equilibrium features a positive nominal interest rate, output at potential, and full employment. The second equilibrium is a liquidity trap, with a zero nominal interest rate, high bond premium, and below-potential output. With pessimistic expectations about employment or safe-asset production, an economy can find itself transitioning to the liquidity trap equilibrium without any change in the fundamentals. When the bond premium is counter-cyclical, expectations of low output imply a higher bond premium and a lower short-term nominal interest rate. If the bond premium is sufficiently high, the presence of the ZLB constrains the central bank in its ability to stabilize the economy, leading to a drop in employment and output, which justifies the agents' pessimism. We label this liquidity trap equilibrium a self-fulfilling liquidity trap (SFLT), following

the seminal work of Benhabib Schmitt-Grohé & Uribe (2001).[5] We show that the issuance of (safe) government debt in small quantities can be contractionary in SFLTs. However, a sufficiently large and credible increase in government debt can eliminate the SFLT. We describe the fiscal capacity needed for such a commitment to be credible and conduct quantitative exercises in a model calibrated to the Great Recession.

The paper, *Understanding Persistent ZLB: Theory and Assessment*, is joint with Pablo Cuba-Borda of the Fed Board. We have been invited to Revise and Resubmit the paper at the *American Economic Journal: Macroeconomics*. In this paper, we compare the narrative of *secular stagnation* and *deflationary expectations-driven traps* using the case of Japan near effective lower bound for twenty years. Under the secular stagnation hypothesis, the natural interest rate consistent with inflation stability is persistently negative because of fundamental factors. Under the expectations hypothesis, following the work of Benhabib Schmitt-Grohé & Uribe (2001),[6] a stable full-employment equilibrium co-exists with a deflationary steady state equilibrium in the presence of a lower bound on nominal rates. Pessimistic expectations of deflation with an active Taylor rule can be self-fulfilling and an economy can spend arbitrarily long time at the lower bound on nominal rates with below target inflation.

We find that the output growth rate and the inflation rate in Japan have been negatively correlated consistently since 1998. Models of secular stagnation with persistently negative neutral interest rates are unable to generate this negative correlation. Expectations-trap hypothesis, which features local indeterminacy, can match the negative correlation if one allows the data to select the equilibria. Using dynamic prediction pools, we show that being able to target the negative output growth- inflation correlation is crucial to explain the Japanese experience at the ZLB. Augmenting secular stagnation with mainstream departures from representative agent rational expectations paradigm such as myopia, diagnostic expectations, heterogenous agents fail to generate this negative correlation during permanent liquidity traps.

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[5] Benhabib, J., S. Schmitt-Grohé, and M. Uribe. 2001. The Perils of Taylor Rules. Journal of Economic Theory.

[6] Benhabib, J., S. Schmitt-Grohé, and M. Uribe. 2001. The Perils of Taylor Rules. Journal of Economic Theory.

The paper, *The Financial Origins of Non-Fundamental Risk*, is joint with Sushant Acharya of the Bank of Canada and Keshav Dogra of the New York Fed. It is unpublished and has been presented at a couple of conferences/seminars. It ties to the theme of safe asset scarcity. Policymakers have often asked if financial sector can create risk rather than amplify existing risks in the economy. In this paper, we show that financial sector can indeed be a source of non-fundamental risk.

We construct a full-information rational equilibrium economy with no fundamental risk whatsoever. The asset markets are complete for all agents who can participate. The only market incompleteness is that there are agents who do not participate in the initial period markets. We show that sunspot equilibria emerge when we allow assets (bonds or price-contingent securities) to be traded.

In our model, fearing that asset prices may fall, risk-averse investors demand safe assets from leveraged intermediaries, whose issuance of safe assets exposes the economy to self-fulfilling fire sales. The key mechanism involves mutual feedback between the risk of a fall in asset prices and investors' purchase of insurance against this risk from financial intermediaries. The fear of a price decline is what motivates investors to demand insurance against such a fall. But it is only because intermediaries sell this insurance to investors that a self-fulfilling fall in prices can occur, as intermediaries are forced to sell assets to meet their obligations in the event of a price decline. The supply of safe assets creates its own demand – a "Say's Law for risk" – whether these safe assets take the form of insurance contracts, options, or risk-free bonds.

From a general equilibrium theory perspective, this paper provides an answer to a question posed by Andreu Mas-Colell in 1992:[7] Can sunspot equilibria exist when underlying economies – absent trading of sunspot-contingent contracts – have unique equilibrium? In our setup, the underlying economy without trade in financial assets features a unique equilibrium that replicates the complete market equilibrium. However, private safe asset creation can give rise to non-fundamental price volatility even when these assets do not have price-contingent or sunspot-contingent payoffs.

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[7] Mas-Colell, A. 1992. Three observations on sunspots and asset redundancy. in Economic Analysis of Markets and Games: Essays in Honor of Frank Hahn, Cambridge, Mass.: MIT Press, pp. 465–474.

The paper, *Log-Linear Approximation versus an Exact Solution at the ZLB in the New Keynesian model*, is joint with Gauti B Eggertsson of Brown University, and has been published in the *Journal of Economic Dynamics and Control*. In this paper, we solve an exact non-linear Calvo (1983)[8] model of price adjustment using the same form of uncertainty as in the log-linearized models. We show that the difference between solving the fully non-linear model or using a log-linear approximation (but taking account of the non-linearity created by the ZLB) is small in the numerical experiments when the non-linear model is re-calibrated appropriately. The non-linear model also generates expansionary effects of contractionary supply shocks as well as fiscal multipliers larger than one at the zero lower bound.

The paper, *A Contagious Malady? Open Economy Dimensions of Secular Stagnation*, is joint with Gauti B Eggertsson of Brown University, Neil R Mehrotra of Minneapolis Fed and Larry Summers of Harvard University. It has been published in the *IMF Economic Review*. In this paper, we study the importance of international capital movements in spreading secular stagnation, and the resulting policy spillovers across countries. We show that greater financial integration may work towards spreading secular stagnation by channeling the savings from the depressed economy to rest of the world. Unilateral policies such as raising inflation targets, structural reforms in labor markets directed towards increasing competitiveness, and promoting exports have beggar-thy-neighbor effects. Reserve accumulation by foreign countries increases the supply of savings at home and may worsen the recession at home. Fiscal policy, by absorbing excess savings, can raise the world real interest rates. Because of positive externalities, fiscal stimulus may be undersupplied. This paper makes a case for fiscal and monetary policy coordination across countries to escape stagnation.

Related Topics in the Open Economy

The paper, *Currency Areas, Labor Markets, and Regional Cyclical Sensitivity* is joint with Katheryn N Russ of UC Davis and Jay C Shambaugh of George Washington University. It has been invited for a Revise and Resubmit at the *IMF Economic Review*, for potential publication in

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[8] Calvo, G. A. 1983. Staggered Prices in a Utility-maximizing Framework. Journal of Monetary Economics.

a conference volume for the IMF's Annual Jacques Polak conference. We investigate the properties of the US economy as a currency union in this paper, building on an influential work by Obstfeld and Peri (1998).[9]   We offer two main analyses. First, we update the Blanchard and Katz (1992)[10] narrative on autocorrelation of state level unemployment rates within the United States. In recent decades, we document significant autocorrelation of state-level and county-level unemployment rates. Second, we estimate the cyclical sensitivity of county unemployment rates to national business cycle, measured with the Congressional Budget Office's unemployment gap for the country. We find and document large heterogeneity across US counties in their cyclical sensitivity.

The paper, *The Effect of Foreign Shocks on Indian Economy*, is joint with Aeimit Lakdawala of Wake Forest University. It was invited for the India Policy Forum 2019, organized by the National Council of Applied Economic Research and the Brookings India. This is a major annual policy conference on Indian economy. We received editorial reports to incorporate comments from two discussants and the conference audience. Following the revisions, the paper has been published in the conference proceedings. In this paper, we document the impact of foreign shocks on Indian macroeconomy. Our contribution is along two main dimensions. First, we focus on estimating dynamic causal effects of international shocks using the recently developed method of identification through external instruments. Second, we consider a comprehensive set of external shocks that are likely to have been important for driving economic fluctuations in India. Our objective is to bring a new set of facts to the macro-policy debate in India.

The paper, *Tariffs and the Macroeconomy*, is joint with Xiangtao Meng of UC Davis and Katheryn N. Russ of UC Davis. We conduct a literature review of recent research at the intersection of tariffs and macroeconomics. It was solicited by and published in the *Oxford Research Encyclopedia in Economics and Finance.*

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[9] Obstfeld, M. and G. Peri. 1998. Regional Nonadjustment and Fiscal Policy. Economic Policy 13(26), 205–259.
[10] Blanchard, O. and L. Katz. 1992. Regional Evolutions. Brookings Papers on Economic Activity 45.

List of Research Papers

1. V. Garga and S.R. Singh. 2021. Output Hysteresis and Optimal Monetary Policy. *Journal of Monetary Economics* 117: 871–886.

2. Ò. Jordà, S.R. Singh, and A.M. Taylor. 2023. The Long-run Effects of Monetary Policy. *mimeo* UC Davis.

3. A. Fatás and S.R. Singh. 2023. Supply or Demand? Policymakers' Confusion in the Presence of Hysteresis. Revised and resubmitted at *European Economic Review*.

4. Ò. Jordà, S.R. Singh, and A.M. Taylor. 2022. Longer-Run Economic Consequences of Pandemics. *The Review of Economics and* Statistics. 104(1): 166–175.

5. Gu, Yumeng and S.R. Singh. 2023. The Distribution of Market Power and Monetary Policy. *mimeo* UC Davis.

6. J-P L'Huillier, S.R. Singh, and D. Yoo. 2023. Incorporating Diagnostic Expectations into the New Keynesian Framework. *The Review of Economic Studies*, accepted.

7. N. Caramp and S.R. Singh. 2023. Bond Premium Cyclicality and Liquidity Traps. *The Review of Economic Studies*, forthcoming.

8. P. Cuba-Borda and S.R. Singh. 2022. Understanding Persistent ZLB: Theory and Assessment. Revise and Resubmit at *American Economic Journal: Macroeconomics*.

9. S. Acharya, K. Dogra, and S.R. Singh. 2023. The Financial Origins of Non-Fundamental Risk. *mimeo* UC Davis.

10. G.B. Eggertsson and S.R. Singh. Log-Linear Approximation versus an Exact Solution at the ZLB in the New Keynesian Model. 2019. *Journal of Economic Dynamics and Control*, 105 (C):21–43.

11. G.B. Eggertsson, N. R. Mehrotra, S. R. Singh and L. H. Summers. 2016. A Contagious Malady? Open Economy Dimensions of Secular Stagnation. *IMF Economic Review*, 64:581–634.

12. K.N. Russ, J. C. Shambaugh, and S.R. Singh. 2023. Currency Areas, Labor Markets, and Regional Cyclical Sensitivity. Revised and resubmitted at *IMF Economic Review*.

13. A. Lakdawala and S. R. Singh. 2019. The Effect of Foreign Shocks on the Indian Economy. *India Policy Forum 2019* Volume 16, SAGE Publications.

14. X. Meng, K. N. Russ and S. R. Singh. 2023. Tariffs and the Macroeconomy. *Oxford Research Encyclopedia in Economics and Finance*.