Research Statement

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I am a quantitative, applied macroeconomist interested in macro public finance, firm dynamics, and labor markets. My research primarily spans four distinct areas. The first focuses on optimal policy design with an emphasis on heterogeneity, showcasing the normative side of my agenda. The second area delves into the macroeconomic implications of business taxation through a positive analysis. In the third, I investigate the influence of household and firm heterogeneity on business cycle dynamics. The fourth and final area is focused on advancements in numerical methods and software design. I provide more detailed explanations of these research branches in the following sections.

What unites my work across these themes is both the field and a consistent approach grounded in core principles I uphold. Foremost, I employ in my work general equilibrium models with heterogeneity. Structural models built rigorously upon microeconomic foundations and accounting for the heterogeneity of economic agents, who interact through various market arrangements, are essential for valid macroeconomic inference. In parallel, I emphasize anchoring macroeconomic frameworks with robust empirical evidence. The present wealth of high-quality datasets and microeconomic insights offers an invaluable opportunity to strengthen conclusions drawn from macroeconomic models. The challenges of working with data-disciplined, heterogeneous agent models, their complexities, and scale often necessitate high-performance computing. Thus, I exploit modern computational technologies and advances in numerical methods to sharpen my economic insights. Finally, macroeconomic theories should consider existing legal restrictions and institutional designs, ensuring that the findings are practically relevant. This combination of quantitative rigor and practical consideration defines my approach to macroeconomic research.

Several of my projects had to be put on hold due to restricted access to Census data and limited availability of computer clusters during the COVID-19 pandemic. I elaborate on this setback at the end of this document.

1 Optimal Policy Design with Heterogeneity.

In light of recent advancements in macroeconomics that incorporate heterogeneous agents, questions regarding optimal policy designs within these frameworks have emerged at the forefront of macro public finance literature. I aim to advance this research frontier through a series of papers. These papers explore various facets of optimal policy design, covering topics such as dynamic individual income taxes, business income taxation, taxation of multinational enterprises, and the optimal carbon taxes within a climate model.

A cornerstone of my research in this area is the paper titled "Optimal Fiscal Policy in a Model with Uninsurable Idiosyncratic Income Risk" [1], published in the *The Review of Economic Studies*. This work addresses a central and long-standing challenge in macro public finance: the Ramsey problem in the standard incomplete markets model (SIM), where agents are exposed to idiosyncratic, uninsurable labor income risk. In this framework, a planner determines optimal time-varying sequences of fiscal instruments, starting at an initial equilibrium and transitioning to an optimal equilibrium. To address this challenge, we developed a numerical method based on a concise approximation of dynamic fiscal policy in the time domain. This method was then applied to an economy modeled to mirror the U.S.'s inequality and individual risk levels. Our findings reveal that the optimal fiscal policy in this context advocates for an initial high and falling capital income tax over time since the tax base, i.e., taxable return on assets, is unequal and inelastic. A pronounced decrease in labor income taxes counteracts the resultant distortions of the intertemporal margin. Such a policy mix generates substantial tax revenues, distributed to households as lump-sum payments. We contend that the planner's dual concerns for efficiency and equality motivate such a policy configuration. Interestingly, these usually conflicting objectives complement each other in this context. Elevated capital income taxes impact the labor supply decisions of wealthier and more productive households, prompting them to work more. Simultaneously, the upfront lump-sum transfers encourage less productive households to reduce labor supply. Collectively, these strategies improve the efficiency of labor allocation and amplify redistribution.

The design of an optimal international corporate tax system is another long-standing topic in the macro public finance literature and remains a relevant and current policy issue. In the paper "Optimal Taxation of Multinational Enterprises: A Ramsey Approach" [2], published in *Journal of Monetary Economics*, we revisit this issue using a model that captures salient features of the contemporary globalized economy: multinational production, intangible capital, and international profit shifting. In our modeling approach, we emphasize international spillovers that manifest as

externalities. Specifically, an increase in intangible investment in one country boosts output and stimulates further intangible investment abroad, implying that allocating intangible investments across countries in a competitive equilibrium is inefficient. Our findings reveal that corporate income taxes have limited utility in the absence of profit shifting, potentially enhancing the efficiency of intangible investment in one country while deteriorating it in others. However, with profit shifting, corporate income taxes can enhance intangible investment efficiency across all countries and fully correct the externality, achieving a Pareto-optimal allocation. In the quantitative section of the paper, we examine the Ramsey planner's problem in an environment with heterogeneous firms and endogenous selection into multinational production and profit shifting. A particularly notable result from our analysis is that, when constrained to Pareto-improving tax reforms, it would be optimal for the planner to increase profit shifting by MNEs compared to the current state. This finding challenges the conventional view that profit shifting is predominantly harmful and should be mitigated.

In my third paper from this research trajectory, "How to Tax Capitalists in the Twenty-First Century?" [3], we address the challenge of devising an optimal fiscal policy in an economy characterized by endogenous decisions regarding tax legal forms of business organization (TLFO). The empirical evidence presented in my paper "The Rise of Pass-throughs: An Empirical Investigation" [4] show that this margin is quantitatively significant and responds to shifts in both the tax and regulatory landscapes. However, it remains relatively unexplored in optimal policy studies. In this particular paper, drawing from the theoretical framework presented in "The Rise of Pass-throughs: a Quantitative Exploration", [5], we consider an economy comprising heterogeneous workers and entrepreneurs. Here, entrepreneurs face a choice regarding their TLFO, oscillating between a pass–through form and a C corporation. Profits from the former directly benefit the owner and are subject to individual income tax code. In contrast, the latter's profits undergo double taxation–first at the entity level, based on the corporate income tax code, and subsequently when disbursed to the owner either as dividends or capital gains, based on the individual tax code. We posit that within the existing U.S. legal structure, policymakers face an essential trade–off between distorting workers' labor supply and capital accumulation and TLFO selection of entrepreneurs. Given a single tax code impacting all three margins, this tension remains unresolved, resulting in limited scope for welfare enhancements. However, our findings reveal that larger welfare improvements become attainable when the policymaker can delineate labor income from business taxation and enforce a uniform business tax. Consequently, we highlight that, with redefined tax bases but an unchanged number of instruments, a revenue–neutral optimal policy outperforms any equivalent approach within the prevailing legal framework. I

raised similar issue about the importance of the endogenous choice of the TLFO for the tax policy design in "Discussion of "Taxation and The Life Cycle of Firms" by Erosa and Gonzalez,", [6], published in *Journal of Monetary Economics*.

In an ongoing research project, I examine a topic recently central to policy discussions and the forefront of macroeconomic research: an optimal design of carbon taxes and a transition to net-zero emissions. In the paper "Optimal Dynamic Dynamic Carbon Taxation with Uninsurable Idiosyncratic Risk", [7], we integrate two research streams. Specifically, we address the challenge of optimally designing a dynamic carbon tax, combining the standard incomplete markets model featuring heterogeneous households with the Dynamic Integrated Model of Climate and the Economy (DICE) 2023, a leading-edge climate model tailored for economic applications. Leveraging techniques from [1], we determine the optimal fiscal policy mix for an economy transitioning to net-zero emissions. The dynamic nature of the fiscal policy is crucial. By employing government debt and adjusting fiscal instruments over time, the planner can accelerate the benefits of net-zero emissions while distributing the economic costs over a transition, thus mitigating the welfare costs of decarbonization.

2 Business Taxation and Macroeconomic Outcomes.

This research trajectory delves into the positive analysis of business taxation and its subsequent influence on macroeconomic outcomes. The papers within this domain first investigate the taxation mechanisms applied to various legal business entities in the United States. Separately, they also explore the taxation of multinational corporations, profit shifting, and intangible capital. The body of work encapsulates both empirical analyses, which utilize novel data to shed light on previously undocumented facts, and the construction of new macroeconomic frameworks tailored for the positive analysis of business taxation.

Over the last four decades, the U.S. business organization landscape has undergone significant change. The conventional C corporation, previously predominant, has given way to pass-through entities. Between 1982 and 2015, the proportion of businesses established as pass-throughs rose from approximately 40% to nearly 70%, with their employment share escalating from 15% to 47%. What has driven this notable shift? And what are the broader macroeconomic consequences of such a transformation? We delve into these inquiries in two companion papers: "The Rise of Pass-throughs: An Empirical Investigation" [4] and "The Rise of Pass-throughs: a Quantitative Exploration" [5]. In the former, utilizing confidential Longitudinal Business Dynamics (LBD) data, we create a novel dataset that includes taxable legal form information for most U.S. businesses

(TLFO LBD). Analyzing this dataset from 1982-2015, we unveil several new facts on the rise of pass–throughs. Despite initial differences across industry and geography, pass–through adoption converges unconditionally, leaving little scope for compositional effects to explain the rising pass-through share. Leveraging a dynamic decomposition approach, we discern that the shifting organizational choices of entrants explain 60% of the 1982-2015 of the 1982-2015 rise. We also see little lifecycle pattern to the legal form, making the initial choice highly persistent. We document several legal and accounting requirements that are significant sources of real reorganization frictions. Our findings indicate that policy changes in the presence of these frictions take decades to fully diffuse through the entry margin and manifest themselves in the data.

In the second paper on this topic, "The Rise of Pass–throughs: a Quantitative Exploration" [5], we develop a quantitative theory of endogenous selection of tax legal forms. Moreover, using the Survey of Consumer Finances (SCF) data set, we document that the rise of pass-through is tightly related to the increase in income inequality in the U.S., and we provide empirical evidence on selection patterns into different tax legal forms. Our theory reflects a stylized trade-off between the forms. Pass-through business owners are taxed according to individual income tax code, have low maintenance costs but face uninsurable investment risk, and finance their operations using retained earnings and debt only. On the other hand, C corporations are taxed twice, first at the entity level and then at the owner once the dividends are paid out. They face higher maintenance costs but can fully diversify risk and have access to external equity. The resolution of these trade-offs generates endogenous selection consistent with the data; conditional on profitability, the propensity to organize a business in pass-through form falls with net worth; conditional on net worth, it drops, albeit much less, with profitability. We further demonstrate that changes in taxes and regulations, starting with significant tax reform in 1986, can largely explain the rise of pass–throughs over the last four decades. Our analysis indicates that this secular trend has had sizeable macroeconomic implications driven mainly by the rise of capital misallocation. It has also contributed significantly to income inequality by concentrating risky though profitable business owners at the top of the income distribution.

In another set of papers on this line of research, we examine the macroeconomic implications of profit shifting by multinational enterprises (MNEs), which recently became a top interest for policymakers in high-tax countries where many of the biggest MNEs are based. The magnitude of profit shifting is striking; recent empirical estimates show that up to 40 percent of worldwide multinational profits are shifted to tax havens. The consequences for public finances are equally striking. According to recent estimates, profit shifting reduces global corporate income

tax revenues by as much as 10 percent annually. Motivated by this evidence, in the paper "A Macroeconomic Perspective on Taxing Multinational Enterprises" [8], revise and resubmit at *Journal of International Economics*, we develop a theory that (i) explicitly describes how MNEs shift profits by transferring the rights to intangible capital, and (ii) connects profit shifting to MNEs' production decisions. We demonstrate that profit shifting is a mechanism of increasing after-tax return on intangible capital and, as such, increases output in domestic and foreign subsidiaries of MNEs. We embody our theory into a multi-country, general-equilibrium framework with heterogenous firms and endogenous selection into exporting and profit–shifting activity. We use the model to quantify its impact on the worldwide allocation of intangible capital, tax revenues, and output. Further, we assess the effects of the recent global OECD's two-pillar tax agreement, which imposes, among other solutions, a minimum global corporate income tax of 15 percent in participating countries. We argue that while this proposal would go a long way toward eliminating profit shifting worldwide by roughly 75 percent, it would also materially reduce intangible investment and overall macroeconomic performance worldwide.

In an ongoing and related work "Effects of Global Corporate Tax Reform on the U.S. Economy" [9], we expand on two papers on taxing multinational enterprises, [8] and [2], and develop a quantitative model suited to evaluate an impact of the global, corporate tax reform specifically on the U.S. economy. The United States, which hosts the largest share of MNEs globally, has made almost no progress in implementing the OECD proposal. This triggers a set of questions about the macroeconomic and fiscal impact of the proposal on the U.S. economy. To address these issues, we extend the baseline framework, developed in [8] and [2], so that it reflects the specific provisions introduced into the U.S. tax code primarily by The Tax Cuts and Jobs Act (TCJA) regarding taxation of MNEs in the U.S. such as Foreign Derived Intangible Income (FDII), global intangible low-taxed income (GILTI) or Base Erosion and Anti-abuse Tax (BEAT), among others. We then quantify their macroeconomic and fiscal impact on the U.S. economy. Furthermore, we use the model to evaluate scenarios ranging from the abolition of TCJA provisions and implementation of OECD's proposal to unilateral adoption of the proposal by major U.S. trading partners such as the European Union.

3 Micro-level Heterogeneity and Aggregate Fluctuations.

In this research avenue, I examine the influence of household and firm heterogeneity on aggregate dynamics throughout the business cycle. The papers in this domain primarily address the living arrangements of young adults in the U.S., their labor market outcomes, and the impact of a firm's

age and size on the severity of financial constraints. This body of work integrates empirical analysis based on microeconomic data with quantitative, structural modeling of business cycle phenomena.

In the paper "Living Arrangements and Labor Market Volatility of Young Workers" [10], accepted by the *Journal of Economic Dynamics and Control*, we provide new evidence on the cyclical behavior of the household size and labor market outcomes of young adults in the United States over the last four decades. Household size is countercyclical, driven mainly by young people moving into or delaying departure from the parental home. We document that young people living with the old work less and earn less, and their hours are more volatile than their peers living alone. We argue that living arrangements induce more significant disparities in labor market outcomes than age. On the modeling front, we develop a joint quantitative theory of living arrangements and labor market outcomes consistent with these empirical regularities. In the model, young adults decide where to live based on aggregate economic conditions, labor productivity, the disutility of shared living arrangements, and implicit consumption transfers they receive once they live with old individuals. As a result, our model features endogenous selection into living arrangements over the business cycle in line with the data. We further use the model to measure the size of implicit transfers, the wedge between labor supply elasticities across living arrangements, and the contribution of the household size variation to the volatility of total hours worked over the business cycle. Our model generates aggregate variation in the total hours far more significant than the variation of hours in response to aggregate shocks resulting from representative agent models with the same preferences. In this sense, we provide a novel channel based on volatile living arrangements through which the macro–labor elasticity is larger than the micro–labor elasticity.

In another paper in this line of research "Fluctuations in Uncertainty, Efficient Borrowing Constraints and Firm Dynamics" [11] I quantify the importance of aggregate fluctuations in microeconomic uncertainty for firm dynamics over the business cycle in economy with endogenously frictional financial markets. To begin, I provide evidence of asymmetric response across age and size groups of firms in the U.S. to the changes in aggregate economic conditions. I argue that age rather than size is a relevant margin determining the employment responses at the firm level. Motivated by these observations, I developed a theory generating endogenously a link between a firm's age and size and its ability to obtain external financing. A vital element of the theory is financial friction, which originated from the firm's private information and a long-term lending contract between the firm and financial intermediary, manifesting as an efficient borrowing con-

straint. Young firms are more constrained in borrowing than old ones, independent of their initial size. As the microeconomic uncertainty increases, the financial contract tightens the borrowing constraint to alleviate the cost of differentiating between good and poorly performing firms. It translates the initial impulse into a decline in demand of the constrained firms for production inputs and further, including general equilibrium effects, into an economic downturn in a constrained efficient economy. A quantitative version of the model explains a sizeable fraction of the fall in aggregate employment and the differential response of employment between young and old firms observed in the U.S. economy during the recent four recessions. In line with the data, the economy experiences a drop in output and investment and a decline in credit to GDP ratio.

4 Numerical Methods and Software Development.

Emerging from my keen interest in high-performance computations, this research avenue underscores the significance of multi-node architectures and parallel programming in addressing macroeconomic challenges. Throughout my career, this reliance has guided me toward contributing to software design, as reflected in "PMFF-GO: A Parallel Modern Fortran Framework for Global Optimization with Economic Applications" [12]. This ongoing project introduces a parallel modern Fortran standalone framework (PMFF-GO) tailored for economic applications. We offer a highly scalable implementation of the global optimization algorithm by harnessing the capabilities of object-oriented programming and co–arrays, both intrinsic to the modern Fortran 2018 standard. Through contemporary software design, we effectively navigate the inherent challenges of parallel programming, including concurrency, data distribution, communication, and load balancing. To facilitate this, we incorporate several cutting-edge techniques and concepts from numerical methods, machine learning, and language design, such as co–arrays, low-discrepancy sequence draws, density-based spatial clustering, optimized static work distribution, and an efficient queueing mechanism. Our initial tests deliver supreme performance of the solver relative to the existing alternatives.

The Impact of COVID-19 Pandemic on My Research

The COVID-19 pandemic had a significant, negative impact on my research portfolio. Three of my papers [4], [5], and [3] are contingent on U.S. Census data, necessitating in-person access at a Research Data Center (RDC). While some projects gained remote access privileges during the pandemic, ours, reliant on U.S. federal tax information from the Census, did not qualify. Consequently, the RDC's closure due to the pandemic and travel restrictions, further compounded by

limitations faced by my co-author in this regard, deprived us of data access for over two years. This disruption led to a prolonged standstill for these three projects. Since the pandemic restrictions have been lifted, we have made substantial progress on these papers. We submitted the empirical paper documenting the main empirical results based on the Census data, [4]. We have been working recently on incorporating these insights into [5] and [3] and on modifying the quantitative environment appropriately. In response to data-access challenges during the pandemic, I started a new line of research, independent of the Census data, on taxation of multinational enterprises, which resulted in three papers [8] [2] and [9]. Additionally, the pandemic adversely affected my research papers that required access to clusters managed by the Digital Research Alliance of Canada: [1], [3], [4], [10], [11]. Computational resources prioritized COVID-related research for approximately a year, further impeding the research progress.

References

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