Research Statement

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October 28, 2021

I am a quantitative macroeconomist. My research focuses on investigating microdata and developing quantitative models to understand and solve economic problems, particularly those where macroeconomics interacts with finance and urban economics. The increasing availability of rich microdata offers researchers unprecedented opportunities to carefully study economic micro-foundations (frictions) and challenges us to better understand aggregate (macro) dynamics while incorporating these rich micro-foundations. I take advantage of the rich heterogeneity in various sources of newly available microdata and develop unique quantitative models to address how micro frictions affect macro dynamics. This allows me to make novel contributions to the study of monetary policy, firm dynamics, financial frictions, asset pricing, housing, and inequality. I refer to this program as Micro Frictions for Macro Dynamics, the organizing theme of all my current research projects, which I discuss in some detail below.

1 Nonconvex Adjustment Frictions and Aggregate Dynamics

The first topic my research addresses is how the existence of nonconvex adjustment frictions affect firm and investor investment decisions. In "Lumpy Investment, Fluctuations in Volatility and Monetary Policy" [1], I study whether monetary policy is less effective at stimulating investment during periods of elevated volatility. Given the lumpy nature of firm-level investment, I argue that elevated volatility leads to a decrease in extensive margin investment, so nominal stimulus generates less aggregate investment. I develop a heterogeneous firm New Keynesian model with lumpy investment and volatility shocks based on my empirical findings. The key idea in the model is that non-convex capital adjustment costs create a sizable extensive margin of investment which is more sensitive to changes in both the interest rate and volatility than the intensive margin. When volatility is high, firms tend to stay inactive at the extensive margin, so monetary stimulus motivates less investment at the extensive margin. I find that the quantitative implications of the model are primarily shaped by the specifications of the capital adjustment costs. Unlike much of the prior literature, I use the dynamic moments of investment to identify this key model element. Based on this parameterization, high volatility reduces the ability of

monetary stimulus to promote investment by 30%.

Motivated by these findings, I further explore the dynamic properties of nonconvex capital adjustment costs in "A Note on Nonconvex Adjustment Costs in Lumpy Investment Models: Mean versus Variance" [2]. I revisit the canonical assumption of nonconvex capital adjustment costs in lumpy investment models as in Khan and Thomas (2008), which are assumed to follow a uniform distribution from zero to an upper bound, which implies a fixed relationship between the mean and the variance. This approach effectively claims that the upper bound, representing the mean size of the nonconvex cost, is all that matters. I show that in order to generate an empirically consistent interest elasticity of aggregate investment, both a sizable mean and a sizable variance are necessary. The mean governs the importance of the extensive margin for aggregate investment dynamics, while the variance governs the sensitivity of the extensive margin to changes in the real interest rate. As a result, both the mean and the variance are quantitatively important for aggregate investment dynamics.

Further, while this nonconvex friction on the firm side is relatively well-studied, how such frictions matter for household investing decisions is under-studied. In "Equilibrium Asset Pricing with Transaction Costs (*Work-in-Progress*)" [3], Luca Gaegauf, Simon Scheidegger, Fabio Trojani, and I are currently working on an equilibrium asset pricing model with flexible and comprehensive nonconvex adjustment costs and multiple assets to study the role of nonconvex adjustment costs on liquidity, trading volatility, and the resulting aggregate implications for asset price and quantities. We are on the stage of solving the equilibrium model in high dimensions with newly developed machine learning methods.

2 Financial Frictions, Investment and Aggregate Dynamics

The second area of my research examines how financial frictions affect investment and saving, a core linkage between the real economy and financial markets. In "Debt Maturity Heterogeneity and Investment Responses to Monetary Policy" [4], Minjie Deng and I study how debt maturity heterogeneity determines firm-level investment responses to monetary policy shocks. We first document that debt maturity significantly affects the responses of firm-level investment to conventional monetary policy shocks: firms who hold more long-term debt are less responsive to monetary shocks. The variations in the magnitude of investment responses due to debt maturity heterogeneity are comparable to the well-documented responses due to debt level heterogeneity. Evidence from credit ratings and borrowing responses indicates that the higher future default risk embedded in longterm debt plays an essential role. We then develop a heterogeneous firm model with investment, long-term and short-term debt, and default risk to quantitatively inter-

pret these facts. Conditional on the level of debt, firms with more long-term debt are more likely to default on their external debt and consequently face a higher marginal cost of external finance. As a result, the investment decisions of these firms are less responsive to expansionary monetary shocks.

In "Financing Innovation with Innovation (*Work-in-Progress*)" [5], Zhiyuan Chen, Minjie Deng and I study how firms could alleviate financial frictions through financing innovation using their innovation capital as collateral. We document that firms increasingly finance innovation with their stock of innovation, measured as patents. Drawing on patent collateral data from the US and China, we find that both the number of pledged patents and the share of patents being used as collateral have been rising steadily in the US and China. However, US patent holders employ patents as collateral at a greater scale and intensity than Chinese patent owners. We show that this difference is probably not due to the liquidity of patent assets, but due to the laggard inspection technology for evaluating patent collaterals for investors. We then construct a heterogeneous firm model featuring idiosyncratic risk, innovation capital, and collateral constraints. In the model, firms can borrow against innovation capital after paying fixed evaluation costs. We parameterize the model to both the US and China and find that the fixed evaluation cost is decreasing over time, but is still much higher in China than in the US. Counterfactual analysis shows that the gains in innovation investment and welfare from reducing frictions in China to the US level are substantial.

In "Sovereign Default Risk and Inequality (*Work-in-Progress*)" [6], Minjie Deng, Philipp Renner, Simon Scheidegger and I study how sovereign default risk affects inequality and vice versa. We build a sovereign default model with heterogeneous households featuring uninsurable idiosyncratic risk, heterogeneous portfolio choices, endogenous unemployment, and endogenous sovereign default risk. In the model, sovereign default affects inequality through forces acting against each other: labor income and capital income. On one hand, sovereign default increases inequality by lowering wages and increasing the unemployment rate. On the other hand, it reduces inequality by lowering the price of capital assets. To quantify the contributions of both channels, we are currently solving and estimating the model using deep learning methods applied to Italian data.

3 Migration Frictions, Spatial Misallocation and Aggregate Dynamics

My third area of research seeks to understand how migration frictions shape the spatial misallocation of labor, housing, productivity, inequality, and their aggregate implications. In "Migration, Housing Constraints, and Inequality: A Quantitative Analysis of China" [7], Zibin Huang and I in-

vestigate the role of migration and housing constraints in determining income inequality within and across Chinese cities. Combining microdata and a spatial equilibrium model, we quantify the impact of the massive spatial reallocation of workers and the rapid growth of housing costs on the national income distribution. We first show several stylized facts detailing the strong positive correlation between migration inflows, housing costs, and imputed income inequality among Chinese cities. We then build a spatial equilibrium model featuring workers with heterogeneous skills, housing constraints, and heterogeneous returns from housing ownership to explain these facts. Our quantitative results indicate that the reductions in migration costs and the disproportionate growth in productivity across cities and skills resulted in the observed massive migration flows. Combined with tight land supply policies in big cities, the expansion of housing demand caused the rapid growth of housing costs and generated further inequality between local housing owners and migrants. The counterfactual analysis shows that if we redistribute the supply of new land proportionally to migrant flows/stocks, within-city income inequality would fall by 14% and national income inequality by 18%. This additionally allows for more migration into cities with higher productivity with corresponding positive consequences for national income.

Motivated by these findings on housing misallocation, we further explore the effect of Chinese land allocation policy interacting with migration frictions in "Regional Convergence or Just An Illusion? Place-based Land Policy and Spatial Misallocation" [8]. Libin Han, Zibin Huang, Ming Lu, Li Zhang and I study how place-based land allocation policy can create spatial misallocation. Combining microdata and a spatial equilibrium model, we investigate a major policy change of distributing more land to underdeveloped inland regions in China. First, by essentially combining RD and DID designs, we show causal evidence that this inland-favoring policy increased land prices and decreased firm-level TFP in more developed eastern regions relative to inland regions. Second, we build a spatial equilibrium model featuring worker mobility and floor space constraints on housing and production. We show that the inland-favoring policy is neither fair nor efficient. Counterfactuals reveal that national TFP and urban output would have been 7.3% and 2.4% higher in 2010 if the policy had not been implemented. Moreover, the incomes of workers from underdeveloped regions would have increased by 1% to 2%. The inland-favoring policy at first glance may seem to reduce regional output gaps, but it actually hurts workers from underdeveloped regions by hindering their migration to developed regions with high wages - while also causing aggregate TFP and output losses. We then show that instead of the inland-favoring land policy, a direct regional transfer can increase the income of people from underdeveloped regions without causing substantial efficiency losses.

We further explore the effects of place-based policy interacting with migration frictions in "(Where to) Set Up Development Zones? Place-based Development Policy and Spatial Misalloca-

tion (*Work-in-Progress*)" [9]. In this paper, we use the mass closure of development zones in 2004 as a natural experiment to examine the causal effect of development zones on firm level TFP in China. In our empirical study, the difference-in-difference estimator shows that, on average, the loss of development zone policies reduces firm TFP by 6.5%. We also show that locational heterogeneity is important. Within 500 kilometers from the three major seaports in China, the closure of zones reduced firm-level TFP by 9.6%, whereas closure of zones farther away did not show significant effects. Market potential and local within-industry spillover effects can explain much of this locational heterogeneity. The data shows that China's strategy of using development zones as a place-based policy to encourage inland development may have led to spatial misallocation. We then extend our model in [8] to include development zones that generate both selection and agglomeration effects, along with intranational and international trade. The separate identification of both effects is possible using our quasi-natural event study. We are currently solving and estimating the model using both Chinese Census data and firm-level data.

4 Other Topics Involving Micro Frictions and Macro Dynamics

In "What Do Alibaba Data Tell Us about Quality Growth in China? (*Work-in-Progress*)" [10], Mark Bils, Zibin Huang, Tianchen Song and I aim to understand to what degree the Consumer Price Index (CPI) measurement of consumer durables reflects either quality growth or inflation. This classic question lies at the core of evaluating inflation and quality growth over time due to measurement frictions at the micro level. In this project, we try to account for quality growth when measuring inflation. As we know, households can substitute for low-quality goods with high-quality ones. If we do not account for quality changes when calculating inflation, we will overestimate the "pure" price increase. The problem is even more severe in developing countries with fast economic growth such as China. In this study, we collaborate with Alibaba Group and use detailed sales and price data for different goods in different regions. We measure the quality growth of mobile phones and how much it contributes to price growth in this market. We are currently working on collecting real-time data across more categories of goods and trying to quantify quality growth for China's retail sector as a whole.

In "Conglomerate Market Power (*Work-in-Progress*)" [11], Tianchen Song, Xiaomei Sui and I study how firms exert market power through their ownership network and the resulting macroeconomic implications due to entry frictions and financial frictions at the micro-level. We first document empirical evidence using French firm-level data from the Orbis Ownership Database and the Orbis Financial Database. We are currently building a dynamic model with heterogeneous firms, ownership networks, and endogenously variable markups. In the model, a controlling par-

ent firm expands through the intensive margin of its own production and the extensive margin by acquiring/establishing subsidiaries. It then influences the production and pricing decisions of its subsidiaries through its ownership rights. As a result, a controlling parent firm exerts market power through its ownership network. We are currently working on extending the empirical findings across more European countries and building/solving the model with European firm-level data. This should allow us to understand how conglomerate market power affects the aggregate economy with respect to aggregate shocks and policy interventions.

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