

The Pennsylvania State University
The Graduate School

**CENTRAL AND LOCAL GOVERNMENT FISCAL BEHAVIOR UNDER
FISCAL FEDERALISM—A THEORETICAL ANALYSIS WITH
EMPIRICAL EVIDENCE**

A Dissertation in
Public Administration
by
Yan Hao

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The dissertation of Yan Hao was reviewed and approved by the following:

Odd Stalebrink

Associate Professor of Public Administration, Pennsylvania State University

Professor-in-Charge, Certificate Program in Public Budgeting and Financial Management

Dissertation Advisor

Chair of Committee

Younhee Kim

Associate Professor of Public Administration, Pennsylvania State University

Professor-in-Charge, Master of Public Administration

Professor-in-Charge, Juris Doctor and Master of Public Administration

Daniel J. Mallinson

Associate Professor of Public Administration, Pennsylvania State University

David Argente

Assistant Professor of Economics, School of Management, Yale University

Goktug Morcol

Professor of Public Administration, Pennsylvania State University

Director of Graduate Studies

Abstract

This dissertation undertakes a comprehensive analysis of the intricate interplay between central and subnational governmental entities within the framework of fiscal federalism. This investigation is structured around the exploration of three distinct inquiries pertinent to both national and subnational administrations. These three inquiries are systematically delineated into two hierarchical levels and subsequently deliberated upon across three dedicated chapters. The findings from these studies offer a comprehensive insight into the complexities of fiscal interactions, advancing our understanding of how intergovernmental transfer mechanisms and governmental strategic behaviors influence the efficiency and effectiveness of public service delivery across different governmental tiers. This enhanced perspective contributes significantly to the field by detailing the conditions under which fiscal policies can be designed to optimize the balance between national objectives and local autonomy, thereby promoting a more equitable distribution of public resources.

Chapter 2 introduces a dynamic game theory model to analyze the strategic interactions between central and subnational governments in the allocation of public goods. Employing backward induction, it reveals how different intergovernmental transfer mechanisms—no provision, joint provision, general transfer, and categorical transfer—affect public goods provision and utility outcomes at both the national and subnational levels. Key findings illustrate the strategic behaviors of governments, demonstrating the conditions under which subnational entities accept categorical transfers. This chapter contributes to understanding the decision-making process in fiscal federalism, highlighting the complex balance between national objectives and local needs.

Chapter 3 examines the influence of political party control on intergovernmental grants in the United States using panel data analysis over 19 years. It uncovers how political alignment between state and federal governments impacts the distribution of intergovernmental transfers. Through Principal Components Analysis and regression models, the study finds that states with unified political control tend to receive fewer grants, challenging the hypothesis that swing states are favored in grant allocation. This analysis provides insights into the role of political factors in fiscal federalism.

Chapter 4 delves into the "flypaper effect" and its implications on local governments' spending behavior following intergovernmental transfers. By reviewing literature and employing a mathematical model, it systematically analyzes how these transfers influence local expenditure decisions. The chapter contributes to the fiscal federalism discourse by offering a comprehensive review of the flypaper effect, demonstrating its significance in

understanding local governments' fiscal responses to federal grants.

Focusing on the impact of grants on subnational governments' revenue collection efforts, Chapter 5 employs a nuanced Ramsey model and Kalman filter estimation to examine how general and categorical grants affect local tax efforts. The study distinguishes between the incentives provided by different types of grants, offering empirical insights into the dynamics of fiscal federalism. It suggests that specific transfer payments can either incentivize or disincentivize local tax effort, highlighting the importance of grant design in enhancing fiscal autonomy and efficiency at the local level.

Key words: intergovernmental transfer, game theory inference, decision making mechanism, political party influence, partisan alignment, fiscal federalism, principal components analysis (PCA), panel data analysis, grant allocation mechanisms, tax collection effort, Ramsey model, kalman filter

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List of Symbols

Chapter 2: Dynamic Game Theory Model

F	Total production output of jurisdiction i.,	p. 83
N	National government,	p. 19
S_h	State government with higher resource endowment,	p. 19
S_l	State government with lower resource endowment,	p. 19
σ	Preference on equalization of central government,	p. 19
T_0	Benchmark amounts under general transfer game,	p. 20
GT	General transfer,	p. 19
CT	Categorical transfer,	p. 19
T_p	productive categorical grants,	p. 21
T_w	Welfare-oriented categorical grants,	p. 21
G	Public goods utility compound,	p. 21
P	Productive-oriented public goods,	p. 21
W	Welfare-oriented public goods,	p. 21
r	match ratio matrix,	p. 21
m	Matching ratio for productive grants,	p. 20
n	Matching ratio for welfare-oriented grants,	p. 20
A_N	The action set for national government,	p. 21
A_S	The action set for subnational government,	p. 21

c_i	The price of public goods in jurisdiction i ,	p. 23
e_j	Tax collecting efficiency of player $j \in P$,	p. 23
a_j	Tax collecting ability of player $j \in P$,	p. 23
f_j	Tax collecting effort of player $j \in P$,	p. 23
y_i	Actual policy position in jurisdiction i ,	p. 22
X_i	Ideal policy position for subnational government i ,	p. 22
X_N	Ideal policy position for national government i ,	p. 22

Chapter 4: Benchmark Model for Flypaper Effect

X	private good,	p. 66
G	public good,	p. 66
y	representative resident's income,	p. 67
τ	lump-sum tax,	p. 67
f	non-matching intergovernmental transfer,	p. 67
α	preference on public and private goods of representative resident,	p. 67
λ_{rc}	lagrange multiplier for representative citizen,	p. 67
λ_e	lagrange multiplier for the economy,	p. 68
λ_{lg}	lagrange multiplier for the local governemnt,	p. 68

Chapter 4: Model for Flypaper Effect with Distortionary Tax

X_t	Private taxable goods,	p. 68
X_{nt}	Private non-taxable goods,	p. 68
θ	Tax rate on X_t ,	p. 68

Chapter 5: Ramsey model on Intergovernmental Transfer's Impact on Tax Collection Behavior

T_{gi}	General transfer to region i ,	p. 82
F_i	Total output in i ,	p. 82
T_0	Benchmark general transfer amount when the tax base in i is 0,	p. 82
σ	The "equalization parameter",	p. 82
P_i	Total productive public spending in i ,	p. 82
W_i	Total welfare public spending,	p. 82
m	Matching ratio for productive public spending,	p. 82
n	Matching ratio for welfare public spending,	p. 82
U_i	Total utility for government in region i ,	p. 83
τ_i	Nominal tax rate in i ,	p. 83
$e_{i,t}$	Tax collection effort in region i at time t ,	p. 83
λ_i	Demand of welfare public goods in region i ,	p. 83
r	Interest rate in equilibrium condition,	p. 84

Preface

One chapter in dissertation involve co-authored work. Chapter 3 (Political Party Control and Intergovernmental Grants: a Panel Data Analysis) is co-authored with Dr Odd. Stalebrink at Pennsylvania State University. I am the first author of chapter 1, chapter 2, chapter 4, chapter 5, chapter 6 and second author of Chapter 3. I received the approval letters from the Graduate School at Pennsylvania State University to include Chapter 3 in my dissertation (see Appendix C).

Chapter 3 is a empirical investigation on how federal transfer payments are influenced by political objectives, highlighting U.S. governance's political nuances.

Regarding the specific contributions to Chapter 3, I was responsible for co-developing the research question, collecting and organizing primary literature, gathering necessary data, designing the research methodology, and writing the code to generate tables and graphs. Based on the content above, I drafted an initial version.

Dr. Stalebrink contribute substantial value to Chapter 3, especially in the manuscript's writing aspects. He conducted extensive revisions, including restructuring the paper and rewriting a lot of parts such as the introduction, literature review, and hypotheses based on the initial draft. His contributions enhanced the quality of the paper. Dr. Stalebrink's expertise and his efforts in the writing process provided crucial academic support for chapter 3.

Acknowledgments

I remember it was an afternoon during exam week. Typically, I would take a nap in the afternoon, but since coming to the United States two years ago, this habit has been sporadic. Coupled with the fact that it was exam week in the winter semester, I, like anyone striving for a decent GPA, spent the entire day in the Sheridan library in Johns Hopkins DC campus, preparing for exams in microeconometrics and Bayesian econometrics.

The view outside the window is so stunning that it's mesmerizing. The streets of DC are clean, yet covered in fallen leaves, flanked by buildings that are several decades, even centuries old. Each building has a stone plaque at its entrance, detailing the stories behind them. The fall season in the Eastern United States already carries a chill, and looking through the window, with raindrops patterning against the glass, I can imagine the cold outside, making the warmth of the fourth floor of the library especially precious.

Lunchtime sandwiches arrived promptly, but within 30 minutes, drowsiness started creeping in. Surrounded by disheveled students slumped over their desks, I realized my brain was in no condition to delve into the intricacies of exogenous identification or any kind of math at that moment. So, I turned to the supplementary reading the professor had recommended. I randomly picked an article and planned to skim through the abstract, just for the sake of it. I can't recall the exact title of that article, but I vaguely remember it was about the theoretical analysis and VAR testing of the effects of fiscal stimulus on economic growth. Surprisingly, I found myself completely engrossed in the article's summary of related literature and its presentation of various perspectives and logical arguments. What's more, out of sheer interest, I ended up tracking down the original articles referenced. Consequently, what was initially meant to be an afternoon dedicated to revising for final exams irrepressibly transformed into several hours of diving into academic literature.

At that time, understanding academic articles was quite challenging for me as a non-native English-speaking graduate student. I struggled through reading three or four articles with only partial comprehension, and before I knew it, the day turned into night. I realized that continuing in this manner would seriously jeopardize my performance in the final exams. It was at that moment, as I looked at the half-darkened sky outside the window, that a thought popped into my mind for the first time: What is the actual explain of this problem? Should I pursue a Ph.D.?

It's been four years now, and I've long forgotten what that initial question was that

sparked my interest in pursuing a Ph.D. The research topics during my doctoral studies have also evolved. At this moment, I am in the process of writing the acknowledgments section of my thesis, marking the nearing conclusion of my Ph.D. journey. Looking back over these past four years, I dare not claim any significant scholarly achievements as a researcher, but I have indeed persevered through each challenging yet fulfilling day. Certainly, apart from the academic endeavors during these four years in Pennsylvania, there have been occasional moments of joy, along with the enjoyment of life, whether through small breakthroughs or savoring moments with a few close friends, especially Yulin Xu and Tiangeng Lu in the wilderness of Pennsylvania, occasionally finding ways to improve life by enjoying good food once upon a time, typically handmade BBQ or that Vietnamese noodle house named "Little Saigon". During the year-long period of staying at home to avoid the COVID-19 pandemic, the rice noodles from Little Saigon were a rare delight for me.

I am profoundly thankful for the invaluable guidance and unwavering support provided by Dr. Odd Stalebrink. His expertise not only enriched my academic pursuits but also equipped me with the resilience to navigate the demanding path of doctoral research. His mentorship extended beyond academic instruction, offering vital insights into overcoming the hurdles inherent in this scholarly journey.

Equally, my gratitude extends to Dr. Kim Younhee, whose teachings in Public Administration have left a lasting impact on my academic and personal development. Dr. Kim's approachable demeanor and profound knowledge greatly enhanced my learning experience, making my journey through the complexities of public administration both enlightening and enjoyable.

I must also express my sincere appreciation for Dr. Mallinson, whose participation in my dissertation committee was invaluable. His critical insights and constructive feedback were instrumental in refining my research, contributing significantly to the depth and quality of my dissertation.

Lastly, I am grateful to Dr. David Argente, my Macroeconomics professor, whose dedication to teaching and academic excellence has been a beacon of inspiration. His transition to Yale University is a testament to his expertise and commitment to higher education. I cherish the learning experiences under his tutelage and wish him the utmost success in his new role.

These acknowledgments barely scratch the surface of my gratitude towards my dissertation committee. Their collective wisdom, encouragement, and academic rigor have been the pillars supporting my doctoral journey, and for that, I am eternally grateful.

Additionally, I am deeply grateful to my mom and dad for providing me with all the support, both material and emotional that parents can possibly offer. They've been doing this for thirty years, especially during my doctoral studies, where it felt like they were going through the degree alongside me. And to my girlfriend Yujie Yang, thank you for your support, especially given the distance of over ten thousand kilometers that separates us on opposite ends of this planet.

Moreover, I must extend my heartfelt thanks to my friends—Jinshen Li, Shiyi Hu, Haiyishaer Nuerlan, and Xinhua Dong. My journey in social interactions has not always

been easy, often finding myself out of my depth in social settings. Yet, it was through the steadfast companionship of these remarkable individuals, friends I've been fortunate to connect with since our undergraduate days, that I've felt supported and connected despite the distances that life has stretched between us. Their enduring friendship, especially during the challenging course of my doctoral studies, has been a beacon of support.

The four years at Pennsylvania State University may not be long in the grand scheme of life, but they are moments I will forever cherish. In the days and nights of my future, I fear I will often find myself reminiscing about the snowy nights where I furrowed my brow in contemplation. Each of these moments will serve as a driving force for my future endeavors and will shape me. There's a Chinese saying, 'at thirty, one stands firm.' In two days, I will turn thirty. In this section of gratitude, aside from expressing my thanks, I also consider it as my own wish list. I hope that in the forthcoming phase of my life, I can have a happy and fulfilling family and pursue a career that I am passionate about and dedicated to.

One should strive continuously to strengthen himself.

Yan Hao

11/07/2023

Two days before my 30th birthday

Chengdu, Sichuan, China.

Chapter 1

Overall Introduction

This dissertation delves into the intricate world of intergovernmental transfer payments, a fundamental component of fiscal federalism that underpins the financial interactions between different tiers of government. Structured around four core chapters, this work navigates from a broad analysis of fiscal dynamics to a nuanced examination of specific fiscal behaviors, embodying a journey from the general to the particular, and from upper to lower levels of government.

Chapter 2 examines intergovernmental interactions and transfer payment strategy formation through a dynamic game model, analyzing both government levels' fiscal behaviors. Chapter 3 focuses on how federal transfer payments are influenced by political objectives, highlighting U.S. governance's political nuances. Chapters 4 and 5 delve into local government fiscal responses to transfer payments, with Chapter 4 evaluating their impact on spending and Chapter 5 on tax collection, respectively.

Given the centrality of fiscal transfer payments to this analysis, and their roots in the concept of fiscal federalism, it is imperative to begin by outlining the structure of fiscal federalism and the role of transfer payments within it, with a particular focus on the United States context. This introduction will pave the way for a detailed discussion on the structure of fiscal federalism and the pivotal role played by fiscal transfer payments.

1.1 Fiscal Federalism: An Overview

Fiscal federalism represents a framework for understanding the financial dynamics between various levels of government, addressing the alignment of expenditure responsibilities with revenue sources within hierarchical government structures. In Musgrave (1971) and Oates et al. (1972)'s concept, "theory of fiscal federalism" concerns the division of public-sector functions and finances in a logical way. This concept is foundational for

efficiently delivering public goods and services, particularly in nations characterized by complex geographical and administrative layers.

The theories of Hayek, Stigler, and Tiebout form the core of fiscal federalism's theoretical basis. Hayek (2009) emphasizes the advantage of local governance in identifying and addressing community needs, while Stigler (1998) advocates for ensuring subnational governments' financial autonomy. Tiebout (1956) introduces the concept of competitive governance, where citizens 'vote with their feet,' choosing jurisdictions that best meet their preferences for public goods and services. This competition among local governments is argued to improve administrative efficiency, a theory supported by empirical evidence, as illustrated in Table A.1, which shows the variance in tax burden preferences across states.

1.1.1 Theoretical Frameworks and Evolutions

Based on my personal review of the literature, fiscal federalism theory has evolved from its initial focus on the allocation of financial resources and responsibilities (first-generation theory) to examining its broader impacts on economic development, political processes, and governance (second-generation theory).

1.1.1.1 First-Generation Theory: Efficiency in Fiscal Structures

The assessment of fiscal structures' efficiency hinges on established economic principles, notably Pareto efficiency, which mandates resource allocation improvements without detriment to others (Pareto, 2014). Key economic considerations—externalities, information asymmetry, and incentive compatibility—frame this evaluation. Oates et al. (1972) discuss the equitable distribution of externalities' costs and benefits within jurisdictions, proposing a model for addressing the "free rider" problem through congruent jurisdictions and beneficiary areas, thereby harmonizing marginal costs and benefits. This principle underlies the tax revenue structure in the U.S., optimizing efficiency and minimizing behavioral distortions in tax collection across jurisdictions, as delineated in Table A.2.

Furthermore, the complexity of information plays a pivotal role in the structural evaluation of fiscal federalism. Drawing on Hayek and Tiebout's foundational work, Besley and Coate (2003) develop a model emphasizing local governance's superior capacity in public goods provision and the central government's calibrated insensitivity. This model underscores the importance of local knowledge and transparency in government actions, enhancing public goods delivery efficiency through decentralized governance

(Baicker, 2005; Martinez-Vazquez & McNab, 2003). Such transparency, facilitated by horizontal competition among local governments, fosters an environment where local entities are motivated to enhance their performance.

Incentive compatibility, introduced by Hurwicz (1973), emerges as a crucial criterion for fiscal federalism, advocating for system designs that align individual actions with collective welfare. This concept is instrumental in encouraging local governments towards efficient public goods provision, leveraging the alignment of funding mechanisms with organizational incentives to foster diligent and effective governance (Eckstein et al., 1958). The assumption that local governments aim to maximize fiscal revenues underpins the administrative strategies within fiscal federalism, influencing the allocation of resources and responsibilities (Baretti et al., 2002b; Bucovetsky & Smart, 2006; Dahlby, 2011; Jha et al., 2000).

Central to first-generation fiscal federalism is the exploration of decentralized structures' efficacy in public goods provision. This theoretical framework endeavors to quantify the effectiveness of fiscal decentralization in enhancing public service efficiency, a pursuit characterized by extensive theoretical exploration.

1.1.1.2 Second-Generation Theory: Beyond Efficiency—Fiscal Federalism's Broader Impacts

Second-generation theories of fiscal federalism delve into its influence beyond the efficiency of public goods provision, examining impacts on economic development (Barro, 1991; Cai & Treisman, 2005), and local government behavior (Jin et al., 2005). Highlighting the complex role of fiscal federalism, especially in developing countries (Bardhan, 2002; Bucovetsky, 2005; Keen & Marchand, 1997; Treisman, 2002), this scholarship identifies three interrelated themes: economic development, political intentions, and local government fiscal conduct.

Tiebout's model serves as the theoretical foundation, yet its assumptions often falter in developing nations where local governments may lack efficiency in public goods provision (Tiebout, 1956). This literature critically evaluates these assumptions, exploring the nuanced interplay between fiscal federalism and economic growth, factoring in labor and capital mobility (Oates, 2004). Faguet (2004) and McKinnon (1993) discuss how fiscal federalism can either stimulate or hinder economic development, emphasizing the variances in resource endowment and the potential for decentralization to exacerbate regional disparities (Cai & Treisman, 2005; Treisman, 2002).

Furthermore, the influence of fiscal federalism on local government's fiscal strategies,

including taxation (Mogues & Benin, 2012), expenditure (Hines Jr & Thaler, 1995), and debt management (Qian & Roland, 1998), is scrutinized, indicating a broad spectrum of governance and policy implications.

Political dynamics also significantly shape fiscal federalism's architecture, with policies in countries like Canada and Australia reflecting an amalgamation of economic efficiency and political strategy (Oates, 2005). However, in contexts like Italy, fiscal transfers have intensified interjurisdictional tensions, presenting a contrasting perspective on fiscal federalism's functionality.

The discourse extends to the interactions within fiscal federalism, distinguishing between horizontal and vertical dynamics, and underscoring the pivotal role of vertical interactions between central and subnational entities in shaping fiscal policies and governance outcomes.

In summary, as depicted in Figure B.3, the original research on fiscal federalism constructed a theoretical framework for efficiently providing public goods. In developed countries, particularly in America, scholars have discovered empirical evidence supporting the advantages of this decentralized fiscal structure. However, in developing countries, fiscal federalism has not worked as effectively, leading to the emergence of second-generation theory. This newer approach focuses on the other side of the coin.

1.2 Fiscal Federalism in the United States

1.2.1 Revenue and Responsibilities of Different Levels of Government

The United States Constitution reserves unspecified rights to state governments, creating a diverse administrative landscape across states due to the country's vast geographical and demographic variety. This diversity results in non-uniform state and local government responsibilities, necessitating a general rather than specific description of administrative structures.

In the American fiscal federalism system, federal, state, and local governments derive income from distinct sources and perform unique roles in public goods provision, with intergovernmental transfers playing a crucial role in financing state and local levels. For fiscal year 2019, federal revenue primarily comprised individual income taxes (50%), corporate income taxes (7%), and social insurance or payroll taxes (36%). State and local revenues significantly rely on intergovernmental transfers, averaging over 30%,

supplemented by sales and property taxes.¹

The expenditure framework reveals distinct roles across government tiers in public goods and services delivery, after excluding debt interest. The federal government funds income security, social security, health, national defense, and infrastructure, among others. State and local governments, meanwhile, focus on public welfare, education, health, and community development.² FigureB.5 and FigureB.2 in Appendix A illustrate the revenue and expenditure patterns, indicating stability with notable annual fluctuations.

1.2.2 Interaction between National and Subnational Governments

The U.S. engages in public goods provision at the subnational level primarily through joint provision and intergovernmental transfers. The federal government influences state and local fiscal decisions through grants-in-aid (GIA) and intergovernmental transfers (IGT), amounting to nearly \$700 billion annually, or about 20% of federal revenue (Dilger & Cecire, 2015). These mechanisms aim to leverage state and local governments' proximity to constituents, fostering efficiency, spatial customization, and democratic engagement (Musgrave, 1997).

Grants-in-aid in the U.S. vary by restriction level and administrative procedures, categorized into categorical grants, block grants, and general revenue sharing grants, with categorical grants dominating in number and fiscal outlay (Dilger & Cecire, 2015). Administrative procedures differentiate grants into competitive, formula-based, and reimbursement grants, each with distinct allocation criteria and objectives.

Joint provision, in contrast, involves direct public goods delivery by the national government, particularly in infrastructure projects. This mechanism simplifies revenue collection and goods provision, bypassing intergovernmental transfers.

This section elucidates the fiscal federalism structure in the United States, highlighting the nuanced revenue and responsibility distribution across government levels and the complex interaction mechanisms that facilitate public goods provision within this framework.

1.3 Impetus and aiming of the Dissertation

The impetus for this dissertation arises from the increasingly complex interplay between central and local governments within fiscal federalism frameworks, particularly under

¹Data Source: The Department of the Treasury and the Bureau of the Fiscal Service

²Data Source: The Department of the Treasury and the Bureau of the Fiscal Service

asymmetric settings. Fiscal federalism, a cornerstone of public administration and economics, explores the allocation of financial responsibilities and resources among different levels of government. This dissertation is driven by a desire to deepen the understanding of how central and local government interactions, shaped by fiscal federalism, affect fiscal behavior and policy outcomes. Despite a wealth of theoretical and empirical studies, gaps remain in our comprehension of the dynamic interactions and the mechanisms behind intergovernmental transfers.

The primary aim of this dissertation is to construct a nuanced theoretical analysis supplemented by empirical evidence that elucidates the strategic decision-making processes and outcomes of fiscal interactions between central and local governments. This study seeks to address the following critical questions:

- How do central and local governments strategize their fiscal policies within the context of fiscal federalism, and what implications do these strategies have for public goods provision?
- How do political dynamics, such as party control and alignment influence the distribution and utilization of intergovernmental grants?
- What are the effects of different intergovernmental transfer mechanisms on the fiscal behavior of local governments, particularly in terms of public goods provision and tax collection effort?

By answering these questions, the dissertation aims to offer a comprehensive understanding of fiscal federalism's practical applications and theoretical underpinnings, focusing on the United States as a case.

1.4 General Overview of Research Approach

This dissertation employs a comprehensive research approach that intertwines theoretical analysis with empirical evidence to explore the complex interplay between central and subnational government fiscal behaviors under fiscal federalism. The objective is to delineate a nuanced understanding of fiscal dynamics across governmental tiers, leveraging a multi-methodological framework that encompasses both deductive and inductive reasoning. This section provides an overview of the research methodology, highlighting the integration of theoretical models and empirical analysis to address the dissertation's central inquiries.

1.4.1 Theoretical Analysis

The theoretical foundation of this dissertation is anchored in a diverse array of analytical frameworks beyond the conventional application of game theory. While game theory provides a structured mechanism to predict strategic interactions between governmental entities, this study extends its theoretical exploration to include mathematical models and economic theories that offer deeper insights into fiscal phenomena.

- Game Theory Models

Central to the analysis are dynamic game theory models that simulate the strategic decision-making processes between the national and subnational governments. These models illuminate the conditions under which different fiscal policies are adopted and their potential outcomes on public goods provision. The game theory approach is instrumental in understanding the strategic underpinnings of fiscal interactions and the implications of various intergovernmental transfer mechanisms.

- Mathematical Conjectures and Models

Beyond game theory, the dissertation employs mathematical conjectures and models to derive theoretical implications of fiscal policies. This includes the utilization of Ramsey models in examining the effects of grants on subnational governments' revenue collection efforts and the analysis of public expenditure behavior through mathematical expressions of the flypaper effect. These mathematical analyses provide a rigorous foundation to theorize the impact of fiscal federalism on government behaviors and policy outcomes.

- Economic Theories and Frameworks

The theoretical analysis is further enriched by the application of economic theories and frameworks that contextualize the mathematical models and game theory simulations within the broader discourse of fiscal federalism. This includes theories of fiscal decentralization, public goods provision, and fiscal illusion. These frameworks offer a conceptual lens through which the empirical findings can be interpreted, bridging the gap between abstract theoretical deductions and real-world fiscal behaviors.

1.4.2 Empirical Analysis

To complement the theoretical analysis, the dissertation incorporates a robust empirical investigation aimed at validating the theoretical models and uncovering real-world evidence of the hypothesized fiscal dynamics. This entails:

- Panel Data Analysis

Utilizing panel data over several years, the dissertation examines the influence of political party control on intergovernmental grants in the United States. This analysis seeks to empirically validate the theoretical predictions concerning the political dimensions of fiscal federalism.

- Case Studies and Comparative Analysis

By reviewing specific instances of fiscal federalism in action, the study provides empirical insights into the practical implications of theoretical models. This includes examining the flypaper effect and its influence on local governments' spending behavior.

- Quantitative Methods

The empirical counterpart of this dissertation employs a synthesis of advanced analytical techniques, collectively referred to here as "Quantitative Analytical Methods." This classification encompasses both Principal Component Analysis (PCA) and Kalman Filter estimation, among others, serving as the empirical foundation upon which theoretical hypotheses are tested against real-world data.

PCA analysis, used predominantly in the examination of political party control on intergovernmental grants, facilitates the distillation of complex datasets into principal components, thus enabling a clearer understanding of underlying patterns and impacts. Similarly, the Kalman Filter, applied in the study of grants' restriction on subnational governments' revenue collection effort, offers a sophisticated method for estimating time-varying parameters within dynamic systems. Together, these Quantitative Analytical Methods bridge the gap between theoretical constructs and their empirical manifestations, providing a rigorous validation of the hypotheses derived from the theoretical analysis.

This integrated approach, combining theoretical analysis with empirical evidence, positions the dissertation to contribute significantly to the understanding of intergovernmental transfer under fiscal federalism system. By bridging the gap between theory and practice, it offers valuable insights into the design of fiscal policies that optimize the balance between national objectives and local autonomy, promoting a more equitable distribution of public resources.

1.5 Significance of the Dissertation

The significance of this dissertation extends beyond academic contributions to the fields of public administration and economics. It provides a critical examination of fiscal federalism's role in shaping the efficiency and equity of public goods provision across different government levels. By integrating game theory models with empirical analysis, this study offers novel insights into the strategic behaviors of central and local governments, highlighting the impact of these behaviors on fiscal policies and outcomes.

For policymakers, the findings of this dissertation offer valuable guidance in designing intergovernmental transfer mechanisms that promote efficient and equitable public goods provision. It sheds light on the importance of considering both financial and strategic dimensions in fiscal policy-making, thereby informing the development of more effective intergovernmental fiscal relations.

Furthermore, this research contributes to the broader discourse on fiscal federalism by challenging and expanding upon existing theories, particularly in the context of asymmetric government settings. It brings to the forefront the critical role of political dynamics in fiscal federalism, emphasizing the need for a holistic approach that accounts for both economic efficiency and political feasibility in the design and implementation of fiscal policies.

In summary, the dissertation stands as a significant endeavor in understanding and improving the intricate mechanisms of fiscal federalism, with implications for both theory and practice in public fiscal management and governance.

1.6 Overview of Subsequent Chapters

This dissertation aims to dissect the multifaceted questions of intergovernmental transfer embodied in fiscal federalism system in United States, with the focus on the interaction between federal government and state government. Given the dual-layered government interaction inherent in this framework, the analysis bifurcates into examining both the central and subnational levels.

Central level inquiries delve into the national government's engagement in subnational public goods provision—choosing between non-involvement, intergovernmental transfers, or direct provision—and the mechanics behind intergovernmental transfer distribution. Subnational level analysis focuses on how local governments respond to federal decisions, specifically regarding expenditure and revenue collection behaviors.

Chapters dedicated to central government questions explore the decision-making processes for engagement methods and intergovernmental transfer mechanisms. Subsequent chapters address subnational reactions, analyzing spending behaviors post-transfer receipt and revenue collection strategies supported by federal grants. Each query is bolstered by theoretical frameworks and empirical validations, structured as a 2×2 matrix for clarity, detailed in Table A.5.

Chapter 2 sets the stage by exploring the overarching issues of intergovernmental interactions, focusing on the mechanisms that shape transfer payment strategies. Employing a fully informed dynamic game model, it elucidates the fiscal behaviors of both upper and lower levels of government, offering insights into the formation of transfer payment mechanisms.

Chapter 3 narrows the focus to the upper government level, specifically examining how transfer payment decisions at the federal level in the United States are influenced by political party objectives, reflecting the political realities of American governance.

Chapters 4 and 5 further refine the scope by concentrating on local government fiscal behavior, divided into public spending and revenue collection actions. Chapter 4 synthesizes existing literature to assess the impact of transfer payments on local government expenditure behaviors, while Chapter 5 investigates the influence of upper-level government transfer payments on the tax collection practices of local governments.

By examining the intricacies of fiscal federalism, this research directly impacts public administration by providing empirical evidence and theoretical insights into how fiscal decentralization influences governmental efficiency and accountability. It sheds light on the critical role of intergovernmental transfers in aligning financial resources with public service demands, revealing the impact of political dynamics on fiscal decisions. This investigation enhances understanding of fiscal policy's role in promoting equitable and efficient public services, offering valuable strategies for public administrators to optimize resource allocation and foster more responsive and responsible governance structures.

Chapter 2 |

Intergovernmental Transfer Decision: an Outcome of the Interaction between Central and Local Government

2.1 Introduction

Fiscal federalism is essential for optimizing the delivery of public goods and services, leveraging local governments' unique insights into community needs (Hayek, 2009; Stigler, 1998). Central to this system are intergovernmental transfers, which facilitate collaboration between central and subnational governments, ensuring efficient provision of public services (Grodzins, 1966; Press, 1963). Despite the recognized benefits of such decentralization, the intricacies of policy outcomes stemming from intergovernmental interactions are not fully understood.

Despite scholarly consensus on the interactive nature of transfer payment formation, the precise mechanisms governing the selection and distribution of transfer payment tools, particularly within the context of the United States, remain elusive (Chubb, 1985; Dixit & Londregan, 1995; Elazar, 1967; Kuic & Elazar, 1988; Treu, 2010; B. Weingast, 1976). The lack of understanding of the mechanism for selecting fiscal tools has led to a limited comprehension of certain fiscal phenomena. For instance, the predominance of categorical transfers, comprising approximately 80% of total transfer payments in the United States, raises questions about the underlying factors driving this distribution imbalance (Dilger & Cecire, 2015).

This chapter introduces a study that aims to bridge the knowledge gaps identified earlier, specifically regarding the decision-making processes guiding the selection of intergovernmental transfer tools and the fiscal phenomena inherent in the transfer payment process. First, it seeks to uncover the decision-making processes guiding the selection of intergovernmental transfer tools. Second, it endeavors to elucidate fiscal phenomena inherent in the transfer payment process, including the flypaper effect, differential impact of direct government involvement versus transferring grants to local governments, and the prevalence of categorical transfer. Grounded in game theory, this study endeavors to provide insights into these fiscal phenomena and contribute to a deeper understanding of the forming mechanism surrounding intergovernmental transfers.

In this chapter, I explore the strategic interactions between central and local governments within fiscal federalism, providing both theoretical insights and empirical evidence. Building on the dissertation's objectives outlined in Chapter 1, this part focuses on how these interactions influence fiscal policy decisions and their implications for public goods provision. By investigating the decision-making mechanisms behind intergovernmental transfers, this chapter offers insights into the fiscal dynamics between governmental tiers, crucial for both theoretical understanding and policy design.

This analysis not only contributes to the academic discourse on fiscal federalism but also guides policymakers in enhancing fiscal collaboration between government levels. Highlighting methodological innovation, the chapter aims to deepen the comprehension of fiscal behaviors across government tiers, directly impacting the design of efficient and equitable fiscal transfer mechanisms.

Summarily, this chapter is integral to the dissertation's aim of examining the complex fiscal interactions under fiscal federalism and lays foundational work for the concluding synthesis of findings.

The forthcoming sections are organized as follows: Initially, a comprehensive background sets the stage, delving into the intricacies of intergovernmental transfer policies. This is followed by a critical literature review, which lays the groundwork by discussing existing theories and identifying gaps this study aims to fill. Subsequently, the method section outlines the construction of the game theory model, detailing its components such as player set, action set, and utility set. The model solving procedure then elucidates the application of backward induction to derive theoretical implications. Results are presented, highlighting the implications of different transfer mechanisms on public goods provision and intergovernmental transfer choices. Finally, the paper concludes with a review and summary, reflecting on the study's contributions to the understanding of

fiscal federalism and intergovernmental transfers.

2.2 Background

This section elucidates the interaction between national and subnational governments in formulating intergovernmental transfer policies within actual administrative processes. Following Volden (2007), the grant-making process encompasses four interrelated decisions. Initially, the national government assesses its participation in subnational public goods provision. Upon deciding to engage, it then determines the modality of support for subnational jurisdictions. Common approaches include direct provision, termed as joint provision, and the issuance of intergovernmental grants. These methods are delineated as follows:

- **Joint Provision**

Here, the national government actively participates in delivering public goods alongside subnational entities. An illustrative example is the collaboration between the United States Department of Labor and subnational governments in administering labor training and rights protection programs, such as the Veterans' Employment and Training Service (VETS) and the Wage and Hour Division (WHD).

- **Intergovernmental Grants**

These grants vary by their allocation mechanisms, encompassing project grants, formula grants, and reimbursement grants. Project grants are competitively awarded, promoting innovative projects at the state level. Formula grants are distributed based on predefined criteria that reflect the social characteristics of jurisdictions(Huffman & Evenson, 2006). Reimbursement grants, either open-ended or closed-ended, compensate state and local governments for specific program expenditures.

Subsequent to the grant allocation mechanism determination, local governments decide on grant acceptance and the application of funds. These sequential decisions culminate in the formulation of public goods provision policy, positioning the national government as either a direct provider, a facilitator through grants, or a non-participant in subnational initiatives.

2.3 Problem Statement

The central problem addressed in this article is to unravel the complexities underlying the formation of fiscal policies governing transfer payments. Contrary to the perception of a straightforward top-down approach, the consensus among scholars suggests that fiscal policy outcomes represent a negotiated compromise across governmental tiers(Chubb, 1985; Dixit & Londregan, 1995; B. Weingast, 1976). Yet, the detailed mechanics of policy tool formulation—encompassing evaluative considerations, sacrifices, and compromises between central and local governments—remain insufficiently integrated into a cohesive analytical framework. This article is particularly concerned with the rationale behind the preferential selection of specific transfer payment instruments and the reasons underlying the disproportionately high reliance on categorical transfers, which account for about 80% of all transfer payments in the United States(Dilger & Cecire, 2015). How can we explain this highly unbalanced distribution of transfer payments?

The research questions guiding this investigation are twofold:

- Mechanism of Intergovernmental Transfer Tool Determination.

This study seeks to demystify the process governing the selection of transfer payment instruments, aiming to elucidate the criteria and considerations driving this choice.

- Examination of Fiscal Phenomena within Transfer Payments.

Leveraging a theoretical framework, the article aims to shed light on fiscal phenomena observed in the transfer payment process, including the flypaper effect and the differential impact of direct government provision versus grant transfers on local public goods provision. A particular focus is placed on explaining the pronounced preference for categorical transfers within the United States.

Through addressing these inquiries, the article endeavors to contribute to the scholarly understanding of fiscal policy formation in intergovernmental transfers, offering theoretical insights into observed fiscal behaviors and policy preferences.

2.4 Literature Review

This literature review is structured around Volden (2007)'s analytical framework, which delineates the interaction between national and subnational governments in the context of fiscal federalism into four distinct categories. By dissecting the literature according

to this schema, this review explores the multifaceted factors influencing the patterns of interaction between different levels of government and identifies areas where this study can make a substantive contribution. The framework begins by examining the central government's role in the first two steps, focusing on the formulation and decision-making processes regarding grants-in-aid. It then transitions to the subnational perspective in the latter two steps, scrutinizing local governments' responses to federal decisions and their strategies for public goods provision. Throughout, this review emphasizes the interplay between national and subnational entities, shedding light on the nuanced dynamics that characterize fiscal federalism.

2.4.1 On National Government Level

The allocation of grants at the central government level is often conceptualized as a strategic bargaining game among key decision-making entities, such as committees, congress, or legislative houses. The seminal work of Baron and Ferejohn (1989) introduced foundational assumptions to the study of these bargaining processes, including random recognition, majority voting rules, and earmarking practices. They made several important assumptions, such as random recognition, majority voting rule, and earmarks rule. Their analysis, further generalized by Banks and Duggan (2006), elucidates how legislators possessing agenda-setting capabilities tend to secure a disproportionate allocation of funds. In a significant development, Martin (2018) nuances this view by limiting the scope of decision-makers to influence only the criteria of funding distribution, not the exact allocations, thereby more accurately mirroring the intricacies of political and administrative decision-making. Contrary to earlier models, Martin's findings suggest the formation of oversized coalitions and the emergence of stable winning groups.

Except for the theoretical investigation of the decision making bargaining process, scholars also focus on the empirical evidence of the impact of some socio-economic factors on grants-in-aid distribution. Markusen et al. (1981) explored temporal shifts in federal grant allocations to cities across different regions during the 1960s and 1970s, uncovering significant increases and regional variations in funding patterns that align with shifts in political landscapes. Similarly, Wallis (1987) and Stegarescu (2006) highlight the political and demographic factors influencing intergovernmental transfers, with Stegarescu pointing to the role of population size, unemployment rates, openness to trade, and political systems in determining the extent of fiscal decentralization. Kasdin (2016) adds to this discourse by illustrating how the network complexity of state or local governance structures can affect both the volume of federal transfers and the degree of

federal oversight, emphasizing the pivotal role of governance networks in shaping fiscal federalism.

This body of literature, focusing primarily on the initial stages of Volden's framework, underscores the multifaceted nature of grant distribution at the national level, revealing a complex interplay of strategic bargaining, socio-economic factors, and political dynamics.

2.4.2 On Subnational Government Level

Volden's framework's concluding phases delve into the realm of local governance, examining how subnational entities respond to federal initiatives and the resultant implications for local spending strategies. This segment of literature underscores the nuanced deliberations local governments undertake when navigating grant opportunities, influenced significantly by political dynamics and fiscal policies.

Nicholson-Crotty (2012) highlights how partisan and electoral pressures significantly shape state-level grant applications, suggesting a strategic calculus behind the acceptance or rejection of federal grants. Complementarily, Volden (2005) explores the competitive dynamics between central and local governments over public goods provision, positing that local governments may control the scale of transfer payments received within their jurisdiction due to potentially greater political leverage. The discourse on the fiscal impact of intergovernmental transfers (IGT) on local government spending is both broad and deep. Pack and Pack (1993) introduce the concept of "fungibility," proposing that local governments might use federal funds to supplant their revenue streams, thereby altering spending patterns on public goods and local taxation. Despite its intuitive appeal, empirical support for this notion remains sparse.

In contrast, the "flypaper effect" garners substantial empirical backing (Gamkhar, 2007; Hines Jr & Thaler, 1995). This theory, articulated by Bradford and Oates (1971), posits that federal grants have a more potent effect on local spending than equivalent increases in local revenue, challenging the equivalence theorem predicated on the median voter theorem and lump-sum tax collection. However, empirical evidence does not support this theorem. Specifically, some researchers have found that a 1 increase in individual revenue leads to an increase in public expenditure of only 0.02 to 0.05, while a 1 increase in intergovernmental transfers can lead to an increase in public expenditure of 0.25 to even 1 (Bailey & Connolly, 1998; Dollery & Worthington, 1996; Gamkhar, 2007). This counterintuitive outcome, extensively documented in over 3500 studies as noted by Inman (2008)'s statistics, underscores the unique influence of federal grants on local fiscal behaviors.

2.4.3 My Rethinking of the Literature

Volden (2007) makes a seminal contribution by developing a game theory framework that intricately links the decision-making processes across government levels in the context of intergovernmental transfers. His model provides a systematic mechanism for understanding the flow of funds from central to local governments. However, the model faces challenges, particularly regarding assumptions about voter information and the scope of transfer tools.

2.4.3.1 Revisiting Voter Information Assumptions

Volden's model presupposes that voters have the capacity to discern the origins of public goods and the allocation of tax burdens, enabling them to assign political credit accurately. This assumption hinges on the notion that voters possess comprehensive information about spending and can attribute credit for public goods provision proportionally (Volden, 2005). The assertion that voters accurately ascribe electoral credit and blame is primarily based on a federalist perspective on vote choice (Stein, 1990). Some earlier empirical literature supports this assumption (Atkeson & Partin, 1995). There is empirical evidence, however, showing that at least in America, voters inaccurately ascribe credit and blame for public goods provision. Studies by Carpinini and Keeter (1996) demonstrates that only 14% of the interviewees are aware of the unemployment rates, and 25% knew about the proportion of federal spending in terms of education resource supply. Additionally, Gilens (2001) indicates that only 12% of the respondents provided correct answers regarding whether the crime rate has risen or declined in the last decade. Needless to say, a substantial body of literature on fiscal illusion, discussing voters' inaccurate sense of the price of public goods, also serves as strong evidence of voters' insufficient information (Borge, 1995; Oates, 1979; Turnbull, 1998). This body of work underscores the complexities of voter knowledge, challenging the assumption of informed electorate decision-making.

2.4.3.2 Expanding the Transfer Toolset

Another critique centers on the model's limited consideration of transfer mechanisms, focusing predominantly on general transfers and overlooking the nuanced role of categorical grants. Given the substantial portion of grant funding categorical transfers represent, especially in policy adjustments, their exclusion narrows the model's applicability. This paper proposes to broaden the framework to include a more diverse array of transfer

instruments, thereby enhancing its relevance and utility.

To address these gaps, this study introduces modifications within a complete information dynamic game framework. It incorporates fiscal illusion considerations, particularly the impact of transparency in public goods provision versus tax collection. Recognizing the differential clarity between these two processes acknowledges the real-world complexities of fiscal federalism. Public goods provision involves more institutions and layers of government compared to tax collection. Bednar (2007) argue that once the level of public goods provision reaches a certain threshold, citizens become indifferent to the supplier of the goods. Similarly, Nicholson-Crotty and Theobald (2011) contend that the political credit derived from public goods provision lacks a clear assignment. Tax collection, on the other hand, is directly linked to the general public, allowing taxpayers to have a clear understanding of the amount of tax collected by various levels of government. To summarize, public goods provision process is less transparent compared to tax collection (Cepparulo et al., 2019; McGillivray & Morrissey, 2019; Pommerehne & Schneider*, 1978).

The expanded model also includes categorical transfers, reflecting a more comprehensive array of tools at the disposal of the central government. This adjustment allows for a richer analysis of policy dynamics and the strategic considerations underpinning intergovernmental fiscal relationships.

By integrating these modifications, the paper not only critiques and builds upon Volden's foundational framework but also offers new insights into the intricacies of fiscal federalism, with a particular focus on the roles of transparency, voter information, and the diversity of transfer mechanisms.

2.5 Method

The theoretical framework is built upon a dynamic game model with complete information. The theoretical implications are derived through backward induction. Following the solution of the game theory model, I will utilize the theoretical implications to elucidate certain fiscal phenomena in intergovernmental transfers.

2.5.1 Game Theory Model Construction

Building upon Volden (2007)'s dynamic game framework, I formulated my own dynamic model. The game is structured as a dynamic game with complete information, signifying

that the utility for all players in this game is common knowledge. The model construction can be delineated from three aspects: players in the game, available behaviors for the players, and utility for the players.

2.5.1.1 Player Set

Three players participate in this intergovernmental transfer game: the central government N , state governments with higher resource endowment S_h , and state governments with lower resource endowment S_l . The assumption of identical subnational governments in Volden's paper is relaxed. Governments with different resource endowments may have varying fiscal preferences, leading to distinct reactions to intergovernmental fiscal policy. The player set can be defined as $P = N, S_h, S_l$. For convenience, I denote $i \in l, h$, where the difference between S_h and S_l lies in the fact that states with higher resource endowments are more productive and possess higher tax bases (GDP). Thus, I have $F_h > F_l$.

2.5.1.2 Action Set

I summary the available action for national government and subnational governments separately.

- **Action set summary for national government**

For the central or national government, one available option is to refrain from participating in the subnational jurisdictions' public goods provision. I refer to this subgame as the "no provision" game. Alternatively, if the national government decides to engage in provision, the next question is how to participate. The available choices include the joint provision game, general transfer game, or categorical transfer game.

In the joint provision game, the national government provides the goods directly. In this scenario, citizens in a specific S_i benefit from the public goods offered by both national and subnational governments combined. In the joint provision game, the national government is the direct provider of the goods and determines the amount of public goods provided to S_i , denoted as G_{Ni} .

Another subgame involves offering intergovernmental transfers. In Volden's framework, the national government can provide grants only through general transfers, which are lump-sum subsidies. I assume there are two types of intergovernmental transfers. Transfers to lower-level governments are either general transfers (GT) or categorical transfers (CT).

CT is more restricted during the spending process, and subnational governments cannot use the grants freely as they wish. As shown in Table A.6, highly restricted grants are only allowed to be spent in specific areas. Volden didn't distinguish between different types of grants in his dynamic game setting. However, the restrictions may play a role in influencing both national and subnational governments' behavior.

The motivation for the national government to choose between general transfer and categorical transfer is different. The primary goal of the national government in participating in the general transfer subgame is to narrow the utility gap of S_i and equalize the original resource endowment difference. The effects of general transfer have been widely discussed in fiscal federalism literature (Bingyang Lv, 2018; Buettner, 2006b). On the other hand, categorical transfer is employed to achieve specific political goals. For instance, the national government may aim to stimulate spending in a particular area. Therefore, differentiating between general transfers and categorical transfers is quite necessary.

I adopted Buettner (2006b)'s design about the amount of general transfer, in which general transfer amount T received by government i can be captured as:

$$T_i = T_0 - \sigma F_i \quad (2.1)$$

where σ captures the central government's subjective intention to equalize resources in different jurisdictions. A higher σ indicates that the national government prefers to equalize resources. For example, compared to the US federal government, OECD central governments may prefer to set a higher σ . T_0 is the benchmark grant amount when S_i has zero F_i . F_i is the total production output, which is also the tax base of S_i .

Compared to general transfers, equity is not a primary concern in the categorical transfer game. The role of categorical grants is to influence policy direction in subnational jurisdictions. By encouraging spending in a specific area, the central government could steer policy output in a nationally favored direction. Categorical transfers are typically matching transfers, where the national government covers a specific percentage of expenditure in a particular area, and subnational governments cover the rest. I assume there are two types of public goods at the subnational level: productive goods (P), such as roads, railways, and other types of infrastructure, and welfare public goods (W), such as social welfare and salaries for public servants.

In the categorical transfer game, I assume the matching ratio for productive grants is m , and the matching ratio for welfare-oriented grants is n . Thus, the productive and welfare-oriented grants received by subnational government i are:

$$\begin{cases} T_p^i = mP_i \\ T_w^i = nW_i \end{cases} \quad (2.2)$$

To summary, the available action for national government is

$$A_N = \{NP, (JP, G_{Ni}), (GT, T_0, \sigma), (CT, m, n)\}$$

- **Action set summary for subnational governments**

For subnational governments, they need to decide on the public goods $G_i|NP$ they provide under the no provision game, the public goods they provide $G_{si}|JP$ under the joint provision game, and the public goods $G_i|GT$ under the general transfer game. I assume subnational governments cannot reject joint provision or general transfer since joint provision and general transfer are lump-sum supplements. For categorical grants, I assume subnational governments may choose to reject based on their utility considerations. If subnational governments choose to reject the grants, then the national government is out of the game, and the game becomes a no provision game. If subnational governments decide to accept the grants, then they need to decide the amount of public goods they provide $G_i|CT$ based on the matching ratios m and n offered by the national government. To summarize, the action set for subnational governments A_i is:

$$A_i = \{(G_i|NP), (G_{si}|JP), (G_i|GT), (Accept, G_i|CT), (Reject, G_i|NP)\}$$

2.5.1.3 Utility Set

I followed the design of Volden's design but with multiple new considerations. The utility of national government and subnational governments are also summarized separately.

- **Utility for subnational government**

For subnational governments, the utility function can be listed as:

$$U_i = \alpha_i G_i - t_i^2 \cdot f_i - \gamma_i |y_i - X_i| \quad (2.3)$$

I set G as Cobb-Douglas form public goods utility compound affected by the amount of P and W .

$$G_i = P^{\beta_i} W^{\epsilon_i} \quad (2.4)$$

α_i is the marginal utility of G_i , which could be explained as the scarcity level of the public goods in place i . β_i and ϵ_i are elasticity of productive public goods and welfare public goods and I assume $\beta_i + \epsilon_i < 1$ since part of the utility also comes from private goods consumption.

The utility for subnational governments comprises three components. Firstly, there is utility derived from the provision of public goods, denoted as G . Secondly, the tax burden, represented by t_i and imposed by both national and subnational authorities, injures the overall utility. The quadratic form of the tax burden reflects the risk-averse disposition of the citizens.

The fraction factor f_i signifies the proportion of blame attributed to the subnational government for tax increases, expressed as $f_i = \frac{t_i}{t_i + t_N}$. It is crucial to note that there is no analogous fraction factor for the credit associated with supplying public goods. This omission accounts for the observation that subnational governments receive full political credit for any augmentation in public goods, regardless of whether the goods are supplied by the national government.

The third segment delineates the policy direction, compressing it into a one-dimensional continuum represented by X_N and X_i " on opposing ends. The actual policy outcome in jurisdiction i , denoted as y_i , resides between these two end points. Each government entity possesses an ideal policy outcome denoted by X_N and X_i . The disparity between the actual policy outcome and the ideal outcome for jurisdiction i , expressed as $|y_i - X_i|$, signifies the influence of both national and subnational factors on policy direction.

The rationale behind $|y - X_i|$ lies in capturing the policy distance, elucidating the divergence between the actual and ideal policy outcomes. Additionally, a parameter $0 < \gamma_i \leq 1$ is introduced, with $\gamma_i |X_N - X_i| = |y_i - X_i|$. This term encapsulates the "alliance effect," reflecting potential collaboration or alignment between national and subnational governments. The parameter γ_i assumes a minimum value when shared ideologies exist between the two levels of government. In cases where federal and state governments occupy polarized positions, $\gamma_i = 1$, indicating a lack of alignment. In this scenario, there exists a maximum distance between the actual policy outcome and the ideal policy point.

Essentially, subnational governments seek to maximize the utility derived from public goods while managing the attribution of tax burden blame from citizens and exerting control over the policy outcome in accordance with their policy preferences.

- **Utility for national government**

For national government, the utility function can be listed as:

$$U_N = \sum_i \alpha_i G_i - \sum_i (t_{Ni} + t_{si})^2 \cdot \frac{t_{Ni}}{t_{Ni} + t_{si}} - \sum_i \gamma_i |X_i - X_N| \quad (2.5)$$

The utility for the national government comprises three components¹. Firstly, the national government is concerned with the utility derived from increasing public goods across all subnational jurisdictions. The second term encapsulates the tax burden attributed to the national government. The third term expresses the utility derived from a policy direction favorable to the national government.

Volden (2007)'s balanced budget assumption continues to apply to both national and subnational governments in this paper. This implies that all tax income is invested in public goods provision. Let c_i denote the price for public goods in jurisdiction i , and e_j represent the tax collection efficiency of player $j \in P$. The efficiency e_j is influenced by various factors such as the number of administrators, salary levels within the tax administration system, and IT expenditure on equipment (Aizenman & Jinjarak, 2008; Kiser & Baker, 1994; Mattos et al., 2011; Savić et al., 2015). Additionally, subjective attitudes, such as the effort exerted by the government in tax collection, also impact e_j .

Under the balanced budget assumption, the equation $\frac{c_i G_s^i}{e_i F_i} = t_i$ holds at the subnational level.

Based on the construction of the game, the interaction process can be listed as figure B.7.

2.6 Model Solving Procedure

The game is solved through backward induction. Initially, subnational governments compare their utility under each subgame and decide whether to accept the offer based on this utility². As this is a complete information game, the national government knows the utility of the subnational government. Subsequently, the national government calculates its own utility based on the choices made by the subnational governments.

To solve the game theory model, the process starts from the tail end of the branch, systematically computing the utility of both subnational and national governments under each subgame.

¹The utility calculation for the national government differs slightly from that in Equation 2.5. I assume the national government issues bonds to collect revenue rather than relying on taxes. This will be elaborated upon in detail later.

²Since subnational governments have no incentive to reject the national government's joint provision and general transfer decision, the utility of subnational governments in the joint provision and general transfer subgame is irrelevant and is therefore not included in the table.

2.6.1 No Provision Game

Under the no provision game, the subnational government is the sole provider of public goods. In this game, utility is determined by the quantities supplied by the subnational government. Additionally, the subnational government bears the entire responsibility for raising the required taxes. Finally, in this game, the subnational government exclusively determines the policy outcome, hence $y_i = X_i$. In this scenario, the utility of subnational governments is expressed as:

$$U_i = \alpha_i G_i - \left(\frac{c_i}{e_i F_i} G_i \right)^2 \quad (2.6)$$

where c_i is the price for the public goods compound.

Equation 2.6 can also be written in P and W as:

$$U_i = \alpha_i P_i^{\beta_i} W_i^{\epsilon_i} - \frac{(c_{p_i} P_i + c_{w_i} W_i)^2}{e_i^2 F_i^2} \quad (2.7)$$

Subnational government would maximize U_i by adjusting P_i and W_i .

$$\begin{cases} \frac{dU_i}{dP_i} = \alpha_i \beta_i P_i^{\beta_i-1} W_i^{\epsilon_i} - \frac{2c_{p_i}(c_{p_i} P_i + c_{w_i} W_i)}{e_i^2 F_i^2} \\ \frac{dU_i}{dW_i} = \alpha_i \epsilon_i P_i^{\beta_i} W_i^{\epsilon_i-1} - \frac{2c_{w_i}(c_{p_i} P_i + c_{w_i} W_i)}{e_i^2 F_i^2} \end{cases}$$

Thus I have

$$\frac{W_i}{P_i} = \frac{\epsilon_i c_{p_i}}{\beta_i c_{w_i}} \quad (2.8)$$

Hence, the objective for subnational governments in the no provision subgame is to maximize utility by adjusting G , where the price of the compound G can be computed as $\frac{c_{p_i} P_i + c_{w_i} W_i}{P_i + W_i}$ ³.

Together with equation 2.8 I have:

$$c_i|_{NP} = \frac{c_{p_i} c_{w_i} (\epsilon_i + \beta_i)}{\epsilon_i c_{p_i} + \beta_i c_{w_i}} \quad (2.9)$$

Subnational governments are deciding the optimal $G_i|_{NP}$ such that utility U_i could reach maximum. So the first order condition is: $\frac{dU_i}{dG_i} = 0$, combined with equation 2.6, optimal solution of G for subnational government can be written as:

³This is not an accurate value for the price of the compound G since G is a Cobb-Douglas compound. However, this price function can be proven to be a bijective function of the real G price.

$$G_i^*|_{NP} = \frac{\alpha_i e_i^2 F_i^2}{2c_i^2} \quad (2.10)$$

Plug equation 2.10 into equation 2.6, the maximum utility under no provision game is:

$$U_i^*|_{NP} = \frac{\alpha_i^2 e_i^2 F_i^2}{4c_i^2} \quad (2.11)$$

For the national government, their concern lies in the utility derived from the collective output of all subnational jurisdictions, as they can still benefit from the utility resulting from voters' consumption of public goods due to citizens' illusion regarding public goods provision. Furthermore, the national government does not bear the blame for tax increases. As a trade-off, the national government must accept the policy inutility stemming from its inability to influence the policy direction. In summary, the utility for the national government in the no provision game is:

$$U_N = \sum_i \alpha_i \frac{\alpha_i e_i^2 F_i^2}{2c_i^2} - \sum_i \gamma_i |X_N - X_i| \quad (2.12)$$

2.6.2 Joint Provision Game

In the joint provision game, both the national and subnational governments contribute directly to public goods provision. For subnational government i , they observe the quantity of goods provided by the national government G_{ni} and then determine the amount of goods they would like to contribute, denoted as $G_{si}|_{JP}$. The tax burden for subnational governments only needs to cover $G_{si}|_{JP}$. Following Volden's framework, in the joint provision game, subnational governments decide the policy outcome⁴. Under the joint provision game and general transfer game, I assume the national government does not alter the optimal proportion. Regarding the tax burden, the total tax burden is $t_{si} + t_N$, and the fraction for state i is $\frac{t_s}{t_s + t_N}$. The taxes from the national government and subnational government can be enumerated as:

$$\begin{cases} t_{si} = \frac{G_s^i c_i}{e_i F_i} \\ t_{Ni} = \frac{\sum c_N G_{Ni}}{e_N \sum F_i} \end{cases}$$

With these three aspects considered, the utility for subnational governments is:

⁴To maximize utility, subnational governments need to provide G at a optimal P-W structure, meaning P and W should maintain the optimal proportion $\frac{W_i}{P_i} = \frac{\epsilon_i c_{p_i}}{\beta_i c_{w_i}}$.

$$U_i|_{JP} = \alpha_i(G_{si} + G_{Ni}) - \left(\frac{c_i G_{si}}{e_i F_i} + \frac{c_N \sum G_{Ni}}{(F_l + F_h)e_N} \right) \cdot \frac{c_i G_{si}}{e_i F_i} \quad (2.13)$$

The first order condition $\frac{dU_i}{dG_i} = 0$ can generate:

$$G_{si}|_{JP} = \frac{\alpha_i e_i^2 F_i^2}{2c_i^2} - \frac{1}{2} \cdot \frac{c_N}{c_i} \cdot \frac{e_i}{e_N} \cdot \frac{F_i}{\sum F_i} \sum G_{Ni} \quad (2.14)$$

The national government derives utility from the supply of public goods and covers the public goods spending across all subnational jurisdictions through taxes, without the ability to influence the policy outcome in jurisdiction i . The utility for the national government in the joint provision game is:

$$U_N|_{JP} = \sum_i \alpha_i G_i - \sum_i (t_{si} + t_{Ni})^2 \cdot \frac{t_{Ni}}{t_{si} + t_{Ni}} - \sum_i \gamma_i |X_N - X_i| \quad (2.15)$$

where $G_i = G_{si} + G_{Ni}$.

2.6.3 General Transfer Game

In the general transfer game, the subnational government is the direct provider of public goods with a lump-sum transfer payment from the national government. The national government lacks the ability to intervene in subnational jurisdictions' policy direction. Subnational governments in this game must decide on public goods supply and policy direction without the need to concern themselves with the entire tax burden. Therefore, the utility for subnational governments is:

$$U_i = \alpha_i G_i - (t_{si} + t_{Ni}) \cdot t_{si} \quad (2.16)$$

where

$$\begin{cases} t_{si} = \frac{G_i c_i - T_i}{e_i F_i} \\ t_{Ni} = \frac{\sum T_i}{\sum F_i e_N} \end{cases}$$

Thus equation 2.16 can be rewritten as:

$$U_i|_{GT} = \alpha_i G_i - \frac{(G_i c_i - T_i)^2}{e_i^2 F_i^2} - \frac{(c_i G_i - T_i) \cdot \sum T_i}{e_i F_i e_N \sum F_i} \quad (2.17)$$

The first order condition based on equation 2.17 is:

$$G_i^*|_{GT} = \frac{\alpha_i e_i^2 F_i^2}{2c_i^2} + \frac{T_i}{c_i} - \frac{1}{2} \cdot \frac{e_i}{e_N} \cdot \frac{F_i}{\sum F_i} \cdot \frac{\sum T_i}{c_i} \quad (2.18)$$

For the national government, utility stems from the combined public goods provided by all jurisdictions, while it bears the necessary burden and cannot exert any influence on the policy direction of subnational jurisdictions. This configuration may seem counterintuitive initially — the national government appears to shoulder the tax burden without receiving corresponding benefits. The rationale lies in the fact that the national government is concerned with the utility of all jurisdictions combined, and the marginal effect of a one-unit increase in product in a low-endowment subnational jurisdiction should be higher than the marginal effect of the same amount of product increase in a highly endowed location. This implies that the national government should be motivated to equalize public goods provision across different places. The utility for the national government in this game is:

$$U_N|_{GT} = \sum_i \alpha_i G_i - \sum_i \left(\frac{G_i c_i - T_i}{e_i F_i} + \frac{\sum_i T_i}{\sum_i F_i e_N} \right) \cdot \frac{\sum_i T_i}{\sum_i F_i e_N} - \sum_i \gamma_i |X_N - X_i| \quad (2.19)$$

2.6.4 Categorical Transfer Game

In the categorical transfer game, subnational governments determine the level of public goods provision based on the matching ratios m and n . Simultaneously, they need to collect taxes to partially fund the goods. In this game, subnational governments cannot arbitrarily set the policy position, as the national government can influence policy directions by imposing restrictions on the grants.

I establish a pair of matching ratios, where $0 < m < 1$ for subnational productive spending and $0 < n < 1$ for welfare-oriented spending.

One notable distinction between the categorical transfer subgame and other subgames is that the categorical transfer alters the public goods price for S_i . Under the new price system, I have:

$$\frac{P_i}{W_i} = \frac{\beta_i c_{wi}(1-n)}{\epsilon_i c_{pi}(1-m)} \quad (2.20)$$

and

$$c_i|_{CT} = \frac{(1-m)(1-n)c_{pi}c_{wi}(\epsilon_i + \beta_i)}{(1-m)\epsilon_i c_{pi} + (1-n)\beta_i c_{wi}} \quad (2.21)$$

Another crucial distinction of categorical transfer is that I assume the national government does not collect taxes to support the categorical transfer. Thus, N does not

face criticism for raising taxes in the categorical transfer game. Instead, the national government can only issue bonds to support categorical transfer but cannot use bonds to support any other programs. For instance, one common method to finance categorical transfer is to issue special bonds. This implies that under categorical transfer, subnational governments bear all the criticism for tax increases, while the national government bears the inutility of issuing bonds. The utility of subnational governments under the new price system is:

$$U_i|_{CT} = \alpha_i G_i|_{CT} - \frac{c_i|_{CT}^2 G_i^2|_{CT}}{e_i^2 F_i^2} - \gamma_i |X_N - X_i| \quad (2.22)$$

The first order condition for subnational governments is: $\frac{dU_i|_{CT}}{dG_i|_{CT}} = 0$
thus I have:

$$G_i^*|_{CT} = \frac{\alpha_i e_i^2 F_i^2}{2c_i^2|_{CT}} \quad (2.23)$$

One evident observation is that categorical transfer is not an intergovernmental transfer with equity consideration. S_h , possessing a greater amount of resources and tax base, can achieve a greater increase in public goods with the same matching ratios m and n .

The utility of the subnational government under categorical transfer with new price became:

$$U_i^*|_{CT} = \frac{\alpha_i^2 e_i^2 F_i^2}{4c_i^2|_{CT}} - \gamma_i |X_N - X_i| \quad (2.24)$$

The national government concerns about the public goods provision conditions in all subnational areas, including S_i and S_h , and must collect revenue to cover a portion of the public goods. In this game, the national government is limited to issuing bonds to support the categorical transfer, while subnational governments are not authorized to issue bonds.

The advantageous aspect for the national government in this game is its ability to influence policy direction by adjusting the matching ratios m and n . An important issue here is how to assess the inutility for the national government when issuing bonds. This question is related to the controversies in economic theory concerning the burden of the national debt. One side of the argument posits that the burden of the debt is borne at the time the debt is issued, while the other contends that the burden of the debt is shifted forward in time (Holcombe et al., 1981; Modigliani, 1961).

Although this thesis evaluates a one-time game, scholars generally tend to attribute the burden of bonds to future generations, signifying a forward shift. Representative topics include discussions on national debt and its impact on inflation, money supply, currency value, and economic growth (Aizenman & Marion, 2011; Cochrane, 2011; Hamburger & Zwick, 1981; Lucas Jr & Stokey, 1983; Panizza & Presbitero, 2014). This thesis does not delve into these discussions in detail. It abstractly simplifies the inutility from two aspects: the size of the bonds and the time to maturity (Diamond, 1965; Fullwiler, 2020; Modigliani, 1961).

Thus, I introduce a term $\delta \cdot D$ to capture the future burden that the national government may undertake, where δ represents the time factor, and D is the size of the burden. The underlying idea is that the inutility for the national government depends on two factors. Firstly, it hinges on how long the national government needs to repay the bonds burden. The national government is less concerned about long-term bonds, thus δ is relatively small when the time to maturity is long. On the other hand, the size of the burden also plays a role in the national government's evaluation.

The utility of national government in this game can be listed as:

$$U_N = \sum_i \alpha_i G_i^* |CT - \delta \cdot D - \sum_i \gamma_i |X_N - y_i| \quad (2.25)$$

One thing to notice here is the policy outcome direction is not fully decided by subnational government, thus $y_i \neq X_i$.

2.7 Results

The implications of the backward induction result can be analyzed from two perspectives. Firstly, implications can arise from the optimal solution of public provision G^* under each game. Another aspect emerges from the mechanism of choice formation.

2.7.1 Implication on Public Goods Provision

- **Proposition 1: In the no provision game, public goods provision and utility are determined by demand, tax collection efficiency, tax base, and cost.**

Subnational government's behavior under the no provision game serves as a benchmark condition. Proposition 1 is straightforward: subnational jurisdictions with greater demand,

higher tax collection efficiency, a larger tax base, and lower public goods cost tend to supply a greater amount of public goods and enjoy higher utility.

- **Proposition 2: In the joint provision game, the public goods supplied by the national government act as a pure squeeze-out for subnational government's public goods provision.**

This contradicts Volden (2007)'s assertion. According to Volden, national government's provision could potentially stimulate subnational governments' provision, as they engage in competition for public goods provision to garner more credit. However, in this model, the influx of national government's public goods leads to a pure squeeze-out effect. This inconsistency could be partly explained by the fiscal illusion embedded in the utility function. Voters or citizens may not be clear about how the tax is utilized and who is supplying the public goods; as long as the public goods meet a specific threshold, voters may not be concerned about whether the contribution comes from the national or subnational government. However, citizens are more sensitive to the tax burden. This mechanism in my model results in a different implication.

Moreover, the size of the squeeze-out effect is influenced by $\sum G_{Ni}$ and several ratios, including $\frac{c_N}{c_i}$, $\frac{e_i}{e_N}$, and $\frac{F_i}{\sum F_i}$, as shown in equation 2.14. It is straightforward to understand that a greater $\sum G_{Ni}$ leads to a larger squeeze-out effect. National taxation to cover $\sum G_{Ni}$ is undertaken by the entire nation, thus a higher $\sum G_{Ni}$ implies that subnational governments need to exercise caution regarding any further tax increase. This squeeze-out effect would be influenced by the parameters $\frac{c_N}{c_i}$ and $\frac{e_i}{e_N}$, meaning that subnational jurisdictions with a greater advantage in tax-raising efficiency and public goods cost compared to the national government would experience a more significant outflow of local public goods provision. It is important to emphasize that S_h would be more heavily affected in terms of the squeeze-out size.

- **Proposition 3: In the general transfer game, subnational governments may increase or decrease public goods provision depending on the size of the income effect and squeeze-out effect.**

The first term of equation 2.18 represents subnational government public goods provision under the no provision game. The second term $\frac{T_i}{c_i}$ is the income effect of the general transfer, as S_i would increase the supply following the $P - W$ structure in equation 2.8 due to the lump-sum subsidy. The third term in equation 2.18 expresses the squeeze-out effect due to the national tax undertaken by the citizens in S_i .

What equation 2.18 tells us is then: whether the public goods in S_i increase or decrease depends on the comparison between $\frac{T_i}{c_i}$ and $\frac{1}{2} \cdot \frac{e_i}{e_N} \cdot \frac{F_i}{\sum F_i} \cdot \frac{\sum T_i}{c_i}$, which equals to:

$$\frac{1}{c_i} \cdot (T_i - \frac{1}{2} \sum T_i \cdot \frac{F_i}{\sum F_i} \cdot \frac{e_i}{e_N}) \quad (2.26)$$

We have $T_i = T_0 - \sigma F_i$, thus $T_l > \frac{1}{2} \sum T_i > T_h$. For S_l , Equation 2.18 should normally be positive. The exception occurs when $\frac{e_i}{e_N}$ is great enough to make Equation 2.18 negative since $\frac{F_i}{\sum F_i} < 1$. The scenario is reversed for S_h , wherein the squeeze-out effect is expected to surpass the income effect, unless the tax collection efficiency for S_h is markedly lower than that of the national government.

2.7.2 Implication on Intergovernmental Transfer Choice

The extensive game concerning the national government's engagement strategy is resolved through backward induction. The national government takes the initial move to determine its participation method in public goods provision, after which subnational governments decide whether to accept or reject the national government's decision. As mentioned earlier, joint provision and general transfer involve free lump-sum subsidies, and thus subnational governments have no incentive to reject the national government's decisions regarding NP and JP . The first step in conducting backward induction involves comparing the utility of subnational governments under the categorical transfer game and the no-provision game. If subnational governments reject categorical grants, the game transitions into a no-provision game, signifying that the national government plays no role in public goods provision.

The initial step in backward induction involves assessing the utility of S_i and S_h , which constitutes the terminal segment of the extensive tree illustrated in Figure B.7. Through backward induction analysis for subnational governments, it is determined that both S_l and S_h would decline categorical transfers unless $U_i|_{CT} > U_i|_{NP}$. Otherwise, subnational governments might opt to reject grants and independently provide public goods without national government assistance. National governments are aware of the potential inclination of subnational governments to refuse grants. To ensure the acceptance of grants, the national government must set the matching ratios m and n at levels that ensure $U_i|_{CT} > U_i|_{NP}$. Consequently, Proposition 4 is presented.

- **Proposition 4: If the national government opts to provide a matching ratio categorical transfer to P , then S_i with a higher price for W is more**

likely to accept the categorical transfer, assuming all other conditions remain equal.

One necessary but insufficient condition for national government to choose categorical transfer is $U_i|_{CT} > U_i|_{NP}$. Utilizing equations 2.11 and 2.24, this inequality can be reformulated as follows:

$$\frac{\alpha_i^2 e_i^2 F_i^2}{4c_i^2|_{CT}} - \frac{\alpha_i^2 e_i^2 F_i^2}{4c_i^2|_{NP}} > \gamma_i |X_N - X_i| \quad (2.27)$$

For subnational governments, the comparison centers on the utility increase resulting from the price effect and the inutility due to policy deviation. The implication is contingent on the magnitude of the price effect.

From equation 2.21, I can calculate:

$$\frac{dc_i}{dc_{pi}} = \frac{(\epsilon_i + \beta_i)\beta_i c_{wi}^2}{(\epsilon_i c_{pi} + \beta_i c_{wi})^2} \quad (2.28)$$

which is a positive value. Thus, in categorical transfer subgame, a lower productive price $c_{pi}|_{CT}$ leads to a lower $c_i|_{CT}$.

$$c_i|_{CT} < c_i|_{NP} \quad (2.29)$$

and also from equation 2.21, we have:

$$\frac{dc_i}{dm} = \frac{-c_{pi} c_{wi}^2 (1-n)^2 \beta_i (\epsilon_i + \beta_i)}{(\epsilon_i c_{pi} (1-m) + \beta_i (1-n) c_{wi})^2} \quad (2.30)$$

The implications of equations 2.28 and 2.30 for this question can be summarized from two perspectives. Firstly, higher values of m and n consistently facilitate the acceptance of categorical grants by subnational governments, an intuitively derived conclusion. Secondly, equation 2.30 can be reformulated as follows:

$$\frac{dc_i}{dm} = \frac{-c_{pi} \left(\frac{\epsilon_i}{\beta_i} + 1 \right)}{\left(\frac{\epsilon_i c_{pi} (1-m)}{\beta_i c_{wi} (1-n)} + 1 \right)^2} \quad (2.31)$$

This suggests that for S_i where the price of welfare-oriented goods is relatively higher, the impact of categorical transfers on productive goods results in a more substantial price effect, consequently yielding greater utility from an increase in public goods. In summary, if the national government opts to provide a matching ratio categorical transfer to P , then S_i with a higher price for W is more likely to accept the categorical transfer,

assuming all other conditions remain equal. A mutual conclusion can be reached when calculating $\frac{dc_i}{dn}$.

Another necessary but insufficient condition for the national government to propose a categorical transfer is $U_N|_{CT} > U_N|_{NP}$, which can be rewritten as:

$$\sum_i \left(\frac{\alpha_i^2 e_i^2 F_i^2}{2c_i^2|_{CT}} - \frac{\alpha_i^2 e_i^2 F_i^2}{2c_i^2|_{NP}} \right) + \sum_i \gamma_i |X_i - y_i| > \delta D \quad (2.32)$$

Due to the utility function's structure, deriving an arithmetic expression for comparing the national government's utility in the categorical transfer subgame and the general transfer game is challenging.

- **Proposition 5: For national government, the evaluation between general transfer and joint provision is decided by the relative price in different regions and national government's provision in different regions G_{Nl} and G_{Nh} .**

The mechanism of the joint provision subgame parallels that of the general transfer subgame in a very similar way, since the national government's behavior in these two subgames doesn't alter the P-W structure. The distinction lies in the fact that, despite facing the same P-W structure, the national government provides goods directly in the joint provision game while extending the subnational government's budget constraint in the general transfer game. This means the price of joint provision game is c_N and in general transfer game is decided by c_l and c_h . The evaluation of $U_N|_{GT} - U_N|_{JP}$ is essentially an assessment of:

$$\frac{c_l \cdot G_{Nl} + c_h \cdot G_{Nh}}{c_N \cdot (G_{Nl} + G_{Nh})} \quad (2.33)$$

The national government, as indicated by Equation 2.33, is obligated to collect taxes and shoulder the associated tax burden. Consequently, the efficiency of tax collection, denoted as e_N , is not a consideration in comparing these two scenarios. The distinction between the two instruments for the national government is elucidated through the comparison between c_N and c_i . Should $\frac{c_l \cdot G_{Nl} + c_h \cdot G_{Nh}}{c_N \cdot (G_{Nl} + G_{Nh})} > 1$, the national government would choose to directly provide public goods rather than resorting to general transfers.

Whether Equation 2.33 exceeds 1 is determined by the relative values of c_i and c_N and national government's provision in i .

I constructed a one-dimensional line segment to depict the relationship between c_i and c_N . The calculation of Equation 2.33 is straightforward when the relationship are

illustrated in Figure B.8. In the depicted relationship, represented by subfigure (a) in Figure B.8, $\frac{c_l \cdot G_{Nl} + c_h \cdot G_{Nh}}{c_N \cdot (G_{Nl} + G_{Nh})} > 1$, prompting the national government to prefer joint provision over general transfer, and vice versa.

When price for public goods by national government lies between c_i and c_{-i} shown in figure B.9⁵.

I define the distance between c_i and c_N as d_1 and distance between c_{-i} and c_N as d_2 . Thus I have

$$\begin{cases} C_i = C_N - d_i \\ C_{-i} = C_N + d_2 \end{cases}$$

Equation 2.33 can be rewritten as:

$$1 + (G_{Nh} \cdot d_2 - G_{Nl} \cdot d_1) \quad (2.34)$$

I define

$$G_{Nl} = a \cdot G_{Nh}$$

to represent national government's provision distribution where a capture the relationship between G_{Nl} and G_{Nh} . Equation 2.34 can be rewritten as:

$$1 + G_{Nl}(a \cdot d_2 - d_1) \quad (2.35)$$

Equation 2.34 implies that when c_N is situated between c_i and c_{-i} , the national government's decision between general transfers and joint provision is determined by $(a \cdot d_2 - d_1)$. This implies that the national government aims to equalize public goods across subnational jurisdictions with minimal tax burden, demonstrating its concern for both c_l and c_h . Under certain circumstances, especially when one jurisdiction faces a significantly higher public goods price, such that $\frac{d_1}{d_2} < a$ (indicated by a large d_2).

- **Proposition 6: The subnational governments aligned with national government are more likely to accept the categorical transfer.**

The condition for subnational governments to accept the categorical transfer is $U_i^*|_{CT} > U_i^*|_{NP}$, which can be rewritten as:

$$\frac{\alpha_i^2 e_i^2 F_i^2}{4c_i^2|_{CT}} - \frac{\alpha_i^2 e_i^2 F_i^2}{4c_i^2|_{NP}} > \gamma_i |X_N - X_i| \quad (2.36)$$

⁵ c_{-i} is the price of S_{-i} , which is the one that is not i among the two.

Aligned governments imply shared policy preferences between national and subnational governments. In extreme circumstances, when the national government precisely aligns with subnational governments in their ideal policy positions ($X_N = X_i$), policy deviation becomes zero. Beyond the policy preference gap between national and subnational governments, alignment with the national government may result in preferential treatment for subnational governments during national decision-making. This, in turn, leads to increased tolerance for policy deviation in categorical transfer games (a smaller γ_i).

2.8 Explain of Fiscal Phenomenon during Intergovernmental Transfer

This paper contributes to the explanation of fiscal phenomena from two perspectives. Firstly, it explores the impact of intergovernmental transfers on subnational spending, encompassing the flypaper effect and fungibility effect. Another area of interest pertains to understanding the dominance of categorical transfers in intergovernmental fiscal arrangements.

2.8.1 Flypaper Effect and Fungibility Effect

As mentioned in the literature regarding the impact of intergovernmental transfers on subnational spending, researchers have found empirical evidence supporting contradictory theories—the flypaper effect and the fungibility effect. While there is substantial evidence supporting the flypaper effect, empirical support for fungibility is comparatively limited (Khilji & Zampelli, 1991, 1994; Zampelli, 1986). The model I have constructed aims to elucidate the flypaper effect by addressing two key questions: firstly, why does the flypaper effect exist? And secondly, why do contradictory conclusions exist, with limited supportive evidence for fungibility?

The flypaper effect of categorical transfers is intuitively reasonable and widely accepted by scholars, as it lowers costs. Therefore, the critical aspect is to explain the flypaper effect of general transfers.

In the game theory model, the contradiction of general transfer can be explained by equation 2.18.

$$G_i^*|_{GT} = \frac{\alpha_i e_i^2 F_i^2}{2c_i^2} + \frac{T_i}{c_i} - \frac{1}{2} \cdot \frac{e_i}{e_N} \cdot \frac{F_i}{\sum F_i} \cdot \frac{\sum T_i}{c_i}$$

Empirical evidence supports both the flypaper effect and the fungibility effect, as demonstrated by the comparison between $\frac{T_i}{c_i}$ and $\frac{1}{2} \cdot \frac{e_i}{e_N} \cdot \frac{F_i}{\sum F_i} \cdot \frac{\sum T_i}{c_i}$. The first term, $\frac{\alpha_i e_i^2 F_i^2}{2 c_i^2}$, represents local public goods provision without external disturbances. The term $\frac{T_i}{c_i}$ reflects the flypaper effect, indicating an increase in provision resulting from general transfers. On the other hand, the term $\frac{1}{2} \cdot \frac{e_i}{e_N} \cdot \frac{F_i}{\sum F_i} \cdot \frac{\sum T_i}{c_i}$ encapsulates the fungibility effect, signifying a decrease in provision due to general transfers. The comparison between the flypaper effect term and the fungibility effect terms can be expressed as follows:

$$T_i - \frac{1}{2} \cdot \frac{e_i}{e_N} \cdot \frac{F_i}{\sum F_i} \cdot \sum T_i \quad (2.37)$$

This equation provides an explanation for the coexistence of contradictory theories—the flypaper effect and fungibility—and sheds light on the limited empirical evidence regarding fungibility. When $T_i > \frac{1}{2} \cdot \frac{e_i}{e_N} \cdot \frac{F_i}{\sum F_i} \cdot \sum T_i$, the flypaper effect prevails. Conversely, if $T_i < \frac{1}{2} \cdot \frac{e_i}{e_N} \cdot \frac{F_i}{\sum F_i} \cdot \sum T_i$, fungibility dominates.

Why evidence of the fungibility effect is relatively scarce remains a question. Building on the analysis of Equation 2.37, I propose explanations for the prevalence of the flypaper effect, as outlined in Propositions 7 and 8.

- **Proposition 7: One factor contributing to the flypaper effect is citizens' aversion to taxes.**

One factor contributing to $T_i > \frac{1}{2} \cdot \frac{e_i}{e_N} \cdot \frac{F_i}{\sum F_i} \cdot \sum T_i$ is the presence of the parameter $\frac{1}{2}$. This parameter arises from citizens' aversion to tax collection⁶. Tax aversion for subnational governments implies that increasing taxes is prohibitively costly, a phenomenon known as the distortion effect of tax increases. This concept aligns with several existing studies explaining the flypaper effect. Hamilton (1986) was the first to observe that the cost of tax collection within a jurisdiction results in a distortionary tax. Dahlby and Ferede (2016) argued that the non-matching grants create a price effect, attributable to subnational governments' information and ability disadvantages. Vegh and Vuletin (2016) arrived at a similar conclusion.

Horizontal government interactions further elucidate this distortion. Brueckner (2003) concludes that lower-level governments are highly sensitive to actions taken by their counterparts, potentially explaining the reluctance of state and local governments to increase taxes for public goods. Other theories of horizontal interaction, such as yardstick

⁶I adopt the square form for tax burden solely for computational convenience in this specific case. Nevertheless, as long as aversion exists, the exponent of the tax burden should exceed 1, resulting in a parameter less than 1.

competition or tax competition, also contribute to understanding this sensitivity (Revelli, 2006; Shleifer, 1985).

- **Proposition 8: Subnational governments with varying resource endowments exhibit different magnitudes of the flypaper effect.**

The fungibility effect is adjusted by two factors $\sum_i \frac{F_i}{F_i}$ and $\frac{e_i}{e_N}$. For S_l , $\sum_i \frac{F_i}{F_i}$ could be a small value, which would lead to $T_l - \frac{1}{2} \cdot \frac{e_l}{e_N} \cdot \sum_i \frac{F_i}{F_i} \cdot \sum T_i > 0$.

In the context of tax collection efficiency, the literature generally concurs that tax collection efficiency is positively associated with the level of economic development (Arvate & Mattos, 2008; Mattos et al., 2011). Regions with lower economic output, denoted as S_l , typically experience reduced tax collection efficiency. This disparity amplifies the gap between T_l and $\frac{1}{2} \cdot \frac{e_l}{e_N} \cdot \sum_i \frac{F_i}{F_i} \cdot \sum T_i$, thereby leading to a larger magnitude of the flypaper effect, vice versa.

An implication drawn from Proposition 8 is that, in entities with imbalanced regional development, underdeveloped regions may exhibit a greater tendency to increase spending upon receiving general transfers. Bowman's 1974 research, using federal education grants to West Virginia as an example to measure the scale of the flypaper effect, found that a one-dollar increase in governmental transfers to school districts resulted in 1.06 times more spending compared to the same increase in tax revenue (Bowman, 1974). In contrast, Weicher's evaluation of the flypaper effect suggested that state grants to school districts in America, on average, led to 0.4 times more spending (Weicher, 1972). Despite both investigations being conducted around the same time and addressing the same topic—the scale of the flypaper effect in school districts—the observed scales differed significantly. One possible explanation for this discrepancy is that West Virginia ranked 48th in GDP.

- **Proposition 9: One potential reason for the flypaper effect empirical evidence in S_l is the relatively disadvantage in tax collection efficiency compared to national government.**

Literature on tax collection efficiency generally share a consent that tax collection efficiency positively related with the economic development level (Arvate & Mattos, 2008; Mattos et al., 2011). A region with low economic output S_l typically leads to lower tax collection efficiency, which enlarge the gap between T_l and $\frac{1}{2} \cdot \frac{e_l}{e_N} \cdot \sum_i \frac{F_i}{F_i} \cdot \sum T_i$, which leads to greater size of flypaper effect. Combined proposition 8 with proposition 9, one deduction is: for those economy entity with imbalanced regional development, those

underdeveloped regions may show greater spending tendency when receiving general transfer. In Bowman's research conducted in 1974, he used federal education grants to West Virginia as example to measure flypaper effect scale (Bowman, 1974). His conclusion is that one dollar increase in governmental transfer to school districts would lead to 1.06 more spending compared to the same increase in tax revenue. As a contrast, Weicher also evaluates the size of flypaper effect and conclude that the states grants to school districts in America would lead to 0.4 more spending on average (Weicher, 1972). These two investigation were generated in roughly same time and discuss same topics: scale of flypaper effect in school districts. However the scale differ greatly. One explanation is: West Virginia ranks 48th in GDP.

- **Proposition 10: One potential reason for the flypaper effect empirical evidence in S_h is citizen's tax aversion.**

One natural following question after proposition 8 and 9 is: how could flypaper effect evidence is also wildly found in high economic output region, such as some empirical research conducted in California, New York and some developed states in India (Bae & Feiok, 2004; Lalvani, 2002; Nguyen-Hoang & Yinger, 2020). The explain is the constant parameter in $\frac{1}{2} \cdot \frac{e_L}{e_N} \cdot \sum F_i \cdot \sum T_i$, which is 1 and $\frac{1}{2}$ here. The difference between the parameter is due to citizen's concave or linear utility on public goods increase and convex tax burden increase.⁷ In other words, citizen gets inertia as public goods increase and sensitive as tax burden increase. So, the general transfer naturally stimulate local governments' spending.

Under what circumstances would regional's choice on public spending shows fungibility? From equation 2.37, we can have a basic image about the jurisdiction that shows fungibility effect to intergovernmental transfer: a region with higher output percentage in total output, higher tax collection efficiency compared to national government, lacking feeling about tax increase.

2.8.2 The Overwhelming Weight of Categorical Transfer

One necessary but insufficient condition for the national government to propose a categorical transfer is $U_N|_{CT} > U_N|_{NP}$, which can be rewritten as:

$$\sum_i \left(\frac{\alpha_i^2 e_i^2 F_i^2}{2c_i^2|_{CT}} - \frac{\alpha_i^2 e_i^2 F_i^2}{2c_i^2|_{NP}} \right) + \sum_i \gamma_i |X_i - y_i| > \delta D \quad (2.38)$$

⁷In my utility setting, the utility for public goods is set as linear to get arithmetic expression, the actual utility maybe concave but this won't change the conclusion here.

The prevalence of categorical transfers can be partly explained by the right side of Equation 2.38. When issued bonds mature over an extended period, or when the national government prioritizes immediate benefits at the expense of future generations' debt burden, categorical transfers become a valuable tool as they alleviate the tax burden. In other words, this represents a trade-off between long-term and short-term utility.

2.9 Review and Summary

In this paper, I aim to elucidate the decision-making process of fiscal policy in public goods provision through the interaction of national and subnational governments. The impact of the joint efforts of national governments on public goods provision, specifically whether it leads to a 'squeeze in' or 'squeeze out' effect on the quantity of public goods in subnational jurisdiction S_i , is influenced by various parameters.

In summary, the key question for subnational governments is whether to accept a categorical transfer once the method is chosen, and the matching ratio is determined by the national government. This decision hinges on the comparison between the utility for subnational governments in a non-provision game and a categorical transfer game. The evaluation for subnational governments involves a trade-off between policy inutility and a lower price. The decision on categorical transfer is the only one jointly made by the national and subnational governments. While rejecting the joint provision or general transfer is not in violation of any rules, subnational governments lack motivation to do so. The rationale is that regardless of whether a subnational government rejects a categorical transfer or joint provision offer, taxes from the national government are imposed on the entire nation. Therefore, accepting the general transfer or joint provision offer would at least prevent the imposition of taxes in vain.

The national government evaluates utility based on the subnational government's level of public goods provision, denoted as G_i^* . The adoption of categorical transfer represents a joint decision by both the national and subnational governments. If the subnational government is satisfied with the categorical transfer offer and it proves to be the optimal choice for the national government among all subgames, then the categorical transfer is implemented.

Compared to Volden's framework, I modified the utility settings and introduced the categorical transfer into the analysis. However, in examining the impact of categorical transfer, the comparison between different games does not yield a straightforward arithmetic solution, representing a limitation in contrast to Volden's original setup.

One distinct conclusion from the modified model, when compared to the propositions in Volden (2007)'s paper, is that the competition effect between the national government and subnational government in providing goods is not as significant; instead, the free rider effect dominates. Consequently, rejecting grants is more likely due to policy outcome deviation and dissatisfaction with the grant scale, rather than stemming from provision competition. Meanwhile, both levels of government are sensitive to tax increases.

Another debatable issue involves the national government's funding mechanism for supporting categorical transfers. In contrast to general transfers and joint provision, the national government in this scenario opts for bond issuance to finance categorical grants rather than relying on taxes. This change introduces ambiguity when evaluating the national government's choice between categorical transfer and other games. Despite this apparent drawback, the setting is reasonable for two main reasons. Firstly, many categorical transfer programs, especially in American and OECD countries, commonly rely on bonds for support (De Mello, 2007; Spahn, 2012; Weist, 2007). Secondly, categorical transfer and general transfer serve distinct purposes for the national government. Categorical transfer aims to stimulate spending in specific areas, while general transfer and joint provision seek to equalize public goods spending across different jurisdictions. Consequently, comparing categorical transfer and general transfer within the same framework is unreasonable.

While I acknowledge that this theoretical inference for fiscal interaction is far from complete, it is impractical to include every possible factor in the model. For instance, Nicholson-Crotty (2012) indicates that subnational governments controlled by different parties exhibit distinct attitudes toward grants. Political factors such as whether the governor is an incumbent or facing an election also play a significant role (MacRae, 1977; Nordhaus, 1975). This paper just provides a general framework for understanding the cognitive mechanisms in governmental joint decision-making and interaction behavior regarding intergovernmental transfers.

Furthermore, empirical evidence is essential to validate the propositions presented in this paper. For certain propositions, well-designed empirical tools are imperative. For instance, I posit that the competition effect is rare, and the refuse of categorical transfers is more likely attributable to policy outcome deviation. In the empirical process, distinguishing whether subnational governments reject grants due to provision competition or policy deviation poses a challenge, as we can only observe behavior, not motivations. Thus, a properly designed empirical test is crucial for future research.

Chapter 3 |

Political Party Control and Intergovernmental Grants: a Panel Data Analysis

3.1 Introduction

The strategic dynamics that exist between different tiers of governments have long been a focal point of fiscal federalism, particularly as they relate to the allocation of intergovernmental transfers (Agrawal et al., 2022; Dahlby, 1996; Gordon, 1983). In the fiscal federalism literature, these dynamics refers to how governments at different levels (e.g., federal, state, and local) elect to respond when their choices are influenced by another government's choices. For example, a federal government that elects to transfer funds through a program that requires a certain level of matching from a subnational government (rather than through a general transfer program) may elicit the subnational government to accept or reject the grant offer. Given the presence of such dynamics, it is critical that they be considered in the design of intergovernmental transfer (IGT) programs (Dahlby, 1996; Gordon, 1983). A failure to properly consider how they affect fiscal behaviors can induce distortions that reduces the effectiveness of government spending, such as overspending by subnational governments or temporary adjustments in tax collections(Bailey & Connolly, 1998; Inman, 2008; Turnbull, 1998).

Academic interest in IGTs has produced a series of studies that offer insights into the complex negotiations and compromises that often characterize the IGT distribution process(Chubb, 1985; Dixit & Londregan, 1995; B. R. Weingast, 1979). Many of the investigations are based on game theory, which assumes that bargaining is carried out

by rational players(Banks & Duggan, 2006; Baron & Ferejohn, 1989; Martin, 2018). However, a limitation of the game-theoretic approach is that it is often grounded in a rational choice paradigm that is at odds with the realities of the environment within which IGTs are distributed. To account for the complex reality of IGT, it is often necessary consider an array of additional factors that goes beyond assumptions of rationality and homogeneity(Golden & Picci, 2008; Milligan & Smart, 2005; Petry et al., 1999; Tellier, 2006). Rosenstiel (2021), for example, points to the need to consider factors such as partisan alignment and preferences for grant categories.

The purpose of this research is to add to the extant body of literature IGTs by examining how political party control affects federal government IGT distributions. Political party control remains a largely unexamined independent variable in analysis of IGT distributions in the US context. In the literature review that was conducted as part of this study, only two previous studies were found that explicitly addresses this topic(Anscombe & Snyder Jr, 2006; Anscombe et al., 2002). This research contributes to this stream by examining the influence of four distinct features of political party control are considered including (1) whether the federal government is unified, (2) the specific party in control, (3) political alignment across the federal and state governments, and (4) political competition across parties.

The analysis is conducted, using a fixed-effect regression model. Using panel data collected from 14 states, we find that political alignment significantly impacts the distribution of intergovernmental grants. Specifically, states with a unified government, where both the administrative and legislative branches at the state and federal levels are controlled by the same party, tend to experience variations in grant allocation. Republican-controlled states under a unified Republican federal government receive a reduced proportion of grants compared to states under bipartisan or Democratic control. Furthermore, our analysis indicates that swing states receive significantly less grant funding compared to their partisan counterparts in non-election years. This suggests a strategic behavior of federal governments, which may allocate resources not solely based on states' needs or economic conditions but also influenced by political considerations and party alignment.

These findings are important because of the scant research that surround the role of political party control in IGT distributions. Despite the presence of a relatively healthy body of theories stream of research that examine the influence of various stakeholders on budget outcomes, this independent variable remains largely unexamined in the US federal context(Patashnik, 2000). It is also significant due to the significant role that politics

play in the budget process. The budget is by many viewed as the prime expression of political preferences. Wildavsky and Caiden (2003) viewed budgeting as the basic framework that makes decision-making in political environments possible. He articulated the role of politics in budgeting as follows: “All Budgeting is about politics, most politics is about budgeting, and budgeting must therefore be understood as part of a political game.”

3.2 Intergovernmental Grants: A Background

Consistent with recent trends in the academic literature(Abbott & Jones, 2012; Akai & Sato, 2019; Lago et al., 2024), this paper uses the terms intergovernmental transfers and grants interchangeably to depict fiscal handovers from one government tier to another. In federal systems, such handovers serve as a multifunctional fiscal instrument, designed to not only instill spending in national-priority sectors but also to harmonize fiscal imbalances across regions. Intergovernmental transfers are therefore often viewed as being instrumental in strengthening subnational entities, and in addressing regional inequities, including vertical disparities rooted in structural differences and horizontal inequities emanating from diverse fiscal capacities and expenditure requirements of subnational jurisdictions.

The process through which intergovernmental transfers are distributed is often depicted through the lenses of a game-theoretic bargaining game. Such a framework is helpful because it captures the strategic dynamics that surround the distribution of intergovernmental grants in democratic environments, and that continues to be a focal point of fiscal federalism(Agrawal et al., 2022; Dahlby, 1996; Gordon, 1983). These dynamics refers to how governments at different levels (e.g., federal, state, and local) elect to respond when their choices are influenced by another government’s choices. For example, a federal government that elects to transfer funds through a categorical transfer program that requires a certain level of matching from a subnational government (rather than through a general transfer program) may influence whether subnational government elects to accept or reject the grant offer. Extant research show that consideration of strategic dynamics is a critical determinant of the success of intergovernmental grants (IG)(Dahlby, 1996; Gordon, 1983). If not accounted for, they may cause fiscal behaviors that reduces the effectiveness of government spending, such as overspending by subnational governments or temporary adjustments in tax collections(Bailey & Connolly, 1998; Inman, 2008; Turnbull, 1998).

Over time, important advances have been made to further refine these frameworks in ways that make them more capable of capturing the strategic dynamics that surround intergovernmental transfers. A seminal contribution in this regard is a paper by Baron and Ferejohn (1989), which laid the foundation for much of the subsequent work. It depicts the distribution of grants as a bargaining game among different decision-making groups, where one participant in the game is the decision-making institution, such as a congress or a specific committee. Baron and Ferejohn (1989) bargaining framework is built around four rules that are regarded as crucial to simulations of the bargaining process that determines grants distribution. These include the recognition rule, voting rule, amendment rule, and money-distribution rule.

1. The recognition rule determines how to select the agenda setter that makes the initial proposal. In the extant literature, most simulations are grounded on the random recognition rule, which assumes that members of the decision-making institution have equal probabilities of being chosen to make the initial proposal (Anesi & Seidmann, 2015; Diermeier & Fong, 2011; Kalandrakis, 2004; Rosenstiel, 2021).
2. The voting rule establishes the standard for passing the proposal, with the majority rule and unanimous voting rule being common assumptions (Baron & Ferejohn, 1989).
3. The amendment rule places constraints on making amendments, ranging from the closed rule (allowing no amendments) to the open rule (allowing any and all germane amendments).
4. The grants-type rule determines how grants could be manipulated by decision-making institutions, with some scholars assuming direct decisions on the number of receivers, referred to as "earmarks" spending models.

Baron and Ferejohn (1989)'s foundational paper also established several important assumptions that accompanied their framework, such as random recognition, majority voting rule, and earmarks rule. Their work, along with a subsequent study by Banks and Duggan (2006), offers three key insights. First, it demonstrates that legislators with agenda-setting power tend to receive a disproportionate share of funding. Second, it demonstrates that, when in a state of equilibrium, funds flow only to legislators in the winning coalition, with no funds allocated to those outside of it. Third, they found that when proposals are brought up under a closed rule, the winning coalition is minimized, leading to the maximization of benefits for the members of the winning coalition.

More recently, a study by Martin (2018) added to Baron and Ferejohn (1989)'s framework by modifying the assumptions of the model, including its heavy reliance on "earmarks." Martin's modified model placed limits on decision-makers' power to determine the factors in the formula rather than the specific numbers. This modification generates a model that is more closely aligned with the realities of political and administrative life. It also produces two conclusions that differs from those of Baron and Ferejohn's model. First, in contrast to the original model, Martin's model predicts oversized winning coalitions and the emergence of persistent winning blocs. Additionally, Martin (2018) demonstrates that when bargaining occurs over a low-dimensional formula , (i.e, less than five variables included in the formula) legislators have limited ability to target funds to specific districts; a prediction supported by empirical evidence. For instance, Martin analyzed existing formula grants and found that 95% of the formulas have fewer than 5 variables, indicating limited bargaining dimensions for members. Consequently, some jurisdictions can be free riders, even if they are not part of the winning coalition. Based on these findings, Martin predicts a positive distribution outside the winning coalition.

However, there are several limitations with applying game-theoretic models to explain IGT distributions. Many of these arise from the fact that they often are grounded in a rational choice paradigm that is at odds with the realities of the environment within which IGTs are distributed. To account for the complex reality of IGT, it is often necessary consider an array of additional factors that goes beyond assumptions of rationality and homogeneity (Golden & Picci, 2008; Milligan & Smart, 2005; Petry et al., 1999; Tellier, 2006). Rosenstiel (2021), for example, points to the need to consider factors such as partisan alignment and preferences for grant categories.

3.3 Political Party Control and IGT Distributions: Literature Review

As noted in the introduction, the purpose of this paper is to examine how the distribution of political party control affects IGT distributions in the US federal budgetary context. In the literature review that was conducted as part of this study, two previous studies were found that explicitly addresses this topic(Ansolabehere & Snyder Jr, 2006; Ansolabehere et al., 2002). Both studies are confined to examining aspects of party control on intergovernmental distributions from state governments to counties. The earlier study (Ansolabehere et al., 2002) examined the distribution of funds from money by states to

counties. Using cross-sectional analysis, it showed that the proportion of legislative seats per person was positively related to the amount of transfers a county received from the state per person. The more recent study (Ansobehere & Snyder Jr, 2006) examined the distributive expenditures across counties in US states over a 40-year period. The study shows that (1) counties that traditionally support (in terms of vote share) the governing party tend to receive larger shares of state transfers, and (2) that the distribution of IGTs tends to follow the direction of the shifts across governing parties.

Borck and Owings (2003) investigates the impact of political factors on the distribution of intergovernmental grants through modeling and empirical data analysis. The core of the research focuses on local government officials lobbying the central government to secure more funding. The article proposes that lobbying costs increase with the geographic and political distance from the central government, theoretically leading to a decrease in grant allocation with increased distance. Their Empirical analysis using county-level data from California finds a negative correlation between grant allocation and geographic distance, aligning with the hypothesized political access costs. Furthermore, the study observes that regions politically aligned with the central government tend to receive more funding. During the response of Covid-19 pandemic in America, Terman (2015, 2020, 2022) and Terman and Feiock (2015)'s series of studies extensively examines how political alignment, partisan relations, and administrative capabilities impact the distribution and efficiency of federal funds. Her findings highlight the significant role of partisan congruence in enhancing the effectiveness of policy implementation during crises like the COVID-19 pandemic.

Similar analysis is also found outside America, Solé-Ollé and Sorribas-Navarro (2008) explore the influence of partisan alignment with upper-level governments on local funding in Spain, demonstrating that local units aligned with higher government tiers tend to receive more funding. These research highlights the significance of political motives in the distribution of intergovernmental grants, showing that the actual allocation of government funding can deviate from ideal efficiency levels due to political influences, even in areas with evident public service spillover benefits.

Besides, a series of studies were produced in the 1970s and 1980s that examined whether party control was related to increases in spending on programs that were ideologically preferred by a particular party. Carlino et al. (2023) find that Republican governors are less inclined than their Democratic counterparts to spend on federal intergovernmental transfers. As a result, states led by Republicans tend to have lower debt levels, delayed taxation, and initially lower economic activity. Overall, At the

state level, these studies offer limited evidence in support of such influence (Fry & Winters, 1970; Lowery, 1987; Marquette & Hinckley, 1981; Plotnick & Winters, 1985, 1990; Winters, 1976). However, at the federal level a stronger correlation was found (Ansolabehere & Snyder Jr, 2006; Browning et al., 1973; Kiewiet & Krehbiel, 2002; Levitt & Snyder Jr, 1995; Owens & Wade, 1984; Ritt, 1976). In addition to this latter finding, this stream of research is valuable in that it offers insights into how to operationalize studies of political control (see methods section).

Explicitly stated, this research adds to the above literature by examining the role of political party control in IGT distributions from the US federal government to the states. In the U.S. federal context, intergovernmental grants are typically classified along two dimensions (Clemens & Veuger, 2023; Dilger & Cecire, 2015), including (1) the level of control that federal agencies exercise in terms of directing how grant funds are used by a subnational government, and (2) the methodologies employed to determine grant amounts or grant shares. The former dimension can be used to categorize three common grant types including categorical grants, block grants and general revenue sharing grants. Among these grant types, categorical grants provide federal agencies with the highest level of control and influence over how state and local government spend awarded funds. They often come attached with language that narrowly defines the purposes for which a subnational government may spend distributed funds.

Block grants signify the distribution of funds that are earmarked for a specific program or project, rather than a narrowly defined spending purpose. Federal agencies exercise less control over block grant programs, compared to categorical grant programs, given that they are earmarked at the program level. For the recipient, they constitute a relatively flexible pool of funds permitting the recipient subnational government to tailor the design and implementation of programs in response to identified regional needs (Finegold et al., 2004).

Finally, general revenue sharing grants refer to grants that are apportioned to subnational governments, using a part of a central government's tax revenues. Sometimes referred to as unconditional grants, they impose very few restrictions on recipient subnational governments. They are distributed to subnational governments through some form of pre-defined formula, defined by law, where the receiving units may or may not be required to match the amounts received (Larkey, 2015). Given that general revenue sharing grants are based on a predefined formula, they extend very limited opportunities for federal agencies to control or influence the distribution of federal funds.

The second dimension mentioned above is the methodologies employed to determine

grant amounts or grant shares. Based on this dimension, relevant grant types include project grants, formula grants and reimbursement grants. Project grants refer to grant funds distributed to fund particular projects or deliverables. This grant type is awarded through a competitive process, encouraging states to propose and execute exemplary projects(Dilger & Cecire, 2015).Formula grants are noncompetitive grants that are allocated to subnational governments based on a pre-defined formula. Such formulas often consider a variety of economic and social characteristics within a jurisdiction(Huffman & Evenson, 2006). Whether formula grants eliminates political motives in resource distribution is unclear yet. Banful (2011) delves into whether Ghana's implementation of the formula-based District Assemblies Common Fund (DACF) effectively eliminates political motivations in intergovernmental grants. The findings indicate that despite the formula-based allocation mechanism, political factors still play a significant role in the distribution of the District Assemblies Common Fund. Especially around elections, the government tends to allocate more funds to key or politically sensitive areas. This suggests that despite the system's design for fairness, political motivations can still influence the actual distribution of resources. Finally, reimbursement grants reimburse state and local governments for a portion of their expenditures on specific programs. They are awarded using open-ended and closed-ended matching grant variations.

In this paper we propose that political party control is channeled into IGT distributions through the level of control that central government agency officials and legislators exercise over such distributions. At the administrative level, this level of control is defined through the laws that accompanies different types of grant programs. For example, non-discretionary grant programs, where allocations are determined by a set formula, offers limited opportunities for federal agencies to control and influence distributions. On the other end, categorical grant programs often extend substantial control to the administrative agencies.

The previously mentioned dimensions used to classify intergovernmental grants provide a useful framework for depicting the level of discretion that accompanies different grant types. Figure B.10 depicts the different grant type possibilities, using a two-dimensional matrix. It suggests that the control that federal agencies and administrators exercise over grant distributions reaches its zenith with categorical project grants. This grant form extends substantial authority to the federal agency in terms selecting recipients and determining grant amounts. Reimbursement grants, while less directly controlled, provides some opportunities for federal agencies to steering benefits towards preferred states.

According to the Congressional Research Service, federal agencies distribute federal funds via close to 600 federal grant programs(Dilger & Cecire, 2015). Close to 70 percent of these programs is some form of project grant(Dilger & Cecire, 2015). Hence, a substantial portion of intergovernmental grants are distributed through grant programs where federal agencies exercises substantial levels of control over grant distributions.

At the legislative level, the influence over grant distributions occurs at the time when legislators establish the basic parameters that guides grant distribution for the various programs. For example, the selection criteria embedded in formula grants can be oriented to favor certain constituencies that reflects legislators' preferences¹. It may also occur indirectly through pressure that legislators impose on administrative agencies.

3.4 Hypothesis

To examine the general proposition that political party control influence IGT distributions, this study considers four factors that we argue captures important aspects of party control. These include (1) whether the federal government is unified, (2) the specific party in control, (3) political alignment across the federal and state governments, and (4) political competition across parties. These factors were included because they have been identified as features of political party control in previous research.

The first feature of political party control that is considered is whether the federal government is unified or not. A unified government is characterized by the alignment of the administrative branch and legislative branch at the federal level under the same political party. A unified government is a feature of political party control, given that it reduces the need for political compromises across parties. Coleman (1999) states that a unified government is productive in public policy outcome. Given this, such alignment is argued to result in higher overall spending. Explicitly stated, the first hypothesis is:

Hypothesis 1: A unified federal government is positively associated with higher overall IGT spending.

The second feature of political party control that is considered is the specific party in control. The Democratic and Republican parties are presumed to exhibit distinct preferences regarding the scale of IGTs(Weaver, 2010; Winters, 1976). However, it is challenging to interpret these differences in party preferences toward IGTs. The Democratic Party tends to favor a larger and more centralized government and the republican

¹While the selection criteria embedded in formula grants can be oriented to favor certain constituencies, such criteria would reflect legislators' preferences at a time that precede the distribution, rather than preferences during the distribution year, presuming these do not coincide.

party tends to favor a smaller and more decentralized government. The Democratic party's preference toward a larger government suggests a positive association with IGT spending. At the same time, the Republican party's preference for decentralization goes hand in hand with IGTs. Consequently, these contrasting preferences lead to divergent conclusions. Given this, the second hypothesis is:

Hypothesis 2: Political party color is related to the level of IGT spending.

The third feature of political party control is the level of political alignment across the federal and state governments. Research by Ansolabehere and Snyder Jr (2006) show that counties that traditionally have supported the governing party (in terms of vote share) receive a larger share of state transfers to local government. They also find evidence that counties with greater legislative seats per person receive more transfer payments from state governments (Ansobehere et al., 2002). In this research, we test whether a similar effect is present in the context of IGT transfers from the federal government to state governments. Explicitly stated, we hypothesize that:

Hypothesis 3: The level of political party alignment across the federal and state governments is positively related to IGT distributions.

The final feature of political party control that is considered is whether a state is a battle ground state or not. The federal government, driven by the motivation to secure election or reelection, is inclined to allocate resources and provide additional public goods to states that significantly influence electoral outcomes. This strategic allocation is aimed at accruing political credits. Veiga and Veiga (2013) reveal how intergovernmental fiscal transfers are utilized as political tools during electoral cycles, with increased transfers to certain regions to boost political support in election years. Dahlberg and Johansson (2002) analyze the strategic allocation of intergovernmental grants in Sweden before elections, supporting the Lindbeck-Weibull/Dixit-Londregan model that governments allocate more funds to areas with a high number of swing voters. Therefore, we argue that swing states are more likely to secure IGTs. Explicitly stated, the final hypothesis is:

Hypothesis 4: Battle ground states are more likely to secure IGTs compared to non-battle ground states.

3.5 Research Approach

To test the above hypotheses, we undertook a two-step analytical approach. The first step was conducted using a principal components analysis (PCA). This step was conducted for purposes of establishing the extent to which IGT distributions are driven by shared

economic and social attributes among same-party states. This step was added to the analysis as a result of Martin (2018) observation that biases in IGT distributions may partially be driven by shared economic and social attributes among same-party states, given that such attributes often determine grant distributions established by formulas. The second step centered on testing the above four hypotheses. Toward this end, we conducted a fixed regression analysis based on the panel data of states in America.

3.5.1 Step 1: Principle Components (PCA) Analysis

In the context of this study, disparities in the distribution of IGTs may stem from two distinct effects. The first effect, which we refer to as the alliance effect, is assumed to arise from a higherlevel government’s preference toward allocating funds to lower-level governments that share its political party affiliation. The political party control features that are examined in this research are assumed to generate alliance effects. The second effect, which we refer to as the preference effect arises from a higher-level government’s preferences toward funding certain economic and social development policies. In terms of IGT distributions, this effect benefits lower-level governments that exhibit certain economic and social characteristics. These shared economic and social attributes may align with political party affiliations. More specifically, numerous American and international studies have provided evidence indicating that factors such as economic structure and economic conditions influence political affiliation. Therefore, it is plausible to infer that the reverse logic holds true: regions governed by the same political party may also share similar economic and social structures(Alan et al., 2009; Anderson, 2006; Weatherford, 1978). Given this, it becomes important to examine the potential influence of the preference effect, before employing regression analysis to investigate the relationship between disparities in transfer payments and political party attributes. If it is established that the preference effect is prevalent, additional controls are necessary to disentangle its effects from those attributed to alliance effects. Hence, the application of PCA prior to regression analysis serves this crucial role. That is, it allows us to determine whether variations in transfer payments are merely a reflection of economic and social characteristics that coincidentally align with political affiliations.

A PCA is a statistical technique that allows researchers to simplify the complexity of highdimensional data while retaining trends and patterns. It allows for this by transforming the original variables into a new set of uncorrelated variables, referred to as the principal components. These principal components are ordered so that the first few variables retain most of the variation present in the original variables. PCA is particularly

useful when analyzing data with numerous interrelated variables to identify underlying structures within the data. For purposes of this research, it allows us to reduce the dimensionality of data, and improves interpretability while minimizing information loss. By focusing on the principal components with the highest variances, it allows us to discern the most significant patterns and relationships within the data.

It is useful to apply when analyzing data with numerous interrelated variables to identify underlying structures within the data. This method is particularly beneficial in reducing the dimensionality of data, improving interpretability while minimizing information loss. By focusing on the principal components with the highest variances, researchers can discern the most significant patterns and relationships within the data.

The primary aim of the PCA that was conducted as part of this study was to distill economic and social characteristics of states into a manageable number of components that could reveal potential clustering by political affiliation. To accomplish this, we (1) standardized the dataset to ensure each variable contributed equally to the analysis; (2) computed a covariance matrix to identify relationships between variables; and (3) extracted eigenvalues and eigenvectors to determine the principal components. Following these three steps, the resulting components were analyzed to determine the extent to which they captured the variance in our data, thereby guiding us in determining the number of dimensions needed for further analysis. This latter step was crucial for isolating the shared economic and social attributes among same-party states. It provided a foundation for understanding how these attributes might influence IGT distributions beyond the surface level of political alignments and preferences.

3.5.1.1 Data and variables for PCA Analysis

The primary variables required mainly consist of economic and social characteristics at the state level, with particular emphasis on variables frequently appearing in transfer payment formulas. Additionally, as this article specifically focuses on the economic and social commonalities among states governed by the same political party, a grouped sampling method was adopted for selecting sample states. All states were categorized into traditional Democratic states, traditional Republican states, and traditional swing states. Within each group, 5-6 states were randomly selected as samples. The economic and social variables of all selected sample states were then analyzed for annual changes from 2000 to 2019, thus forming a panel dataset.

The state grouping method relies on two primary criteria: historical presidential election outcomes and their corresponding winning percentages, a methodology delineated

in Beachler et al. (2015). Democratic and Republican states are characterized as those consistently favoring a particular party in presidential elections since 1984, where the winning rates surpass 58%. Swing states are recognized as those that have alternated between parties in selecting presidents, with winning rates falling below 58%. The states encompassed within the analysis are enumerated in Table A.7.

The social and economic characteristics commonly included in the formula for inter-governmental transfers encompass population, working-age population weight, median household income, unemployment rate, road mileage, and GDP per capita (Dilger & Cecire, 2015). I gathered all factors mentioned in Dilger and Cecire (2015)'s study for the sampled states. Additionally, I referenced major intergovernmental transfer programs such as Medicaid, the Title I-A education program, Temporary Assistance for Needy Families (TANF), Section 8 Housing Choice Vouchers, and the Community Development Block Grant (CDBG) to comprehensively collect factors. To ensure data convenience for regression and enhance data visualization, I performed appropriate operations. The collected characteristics and data sources are detailed in Table A.9.

3.5.1.2 PCA Process and Results

Issues of correlation across the collected variables are evident. For example, the weight of the working-age population and the unemployment rate are highly interdependent. Moreover, higher population levels inherently correspond to increased usage of public roads. This observation is further corroborated by the correlation heatmap, depicted in Figure B.11, which indicates a certain degree of correlation among the variables. As such, we conclude that PCA is needed to reduce data dimensionality and mitigate issues of multicollinearity.

To address the first question, the apparent hindrance lies in the difficulty of directly assessing the similarity of jurisdictions in social and economic characteristics. To overcome this challenge, I employed Principal Components Analysis (PCA) to reduce data dimensionality and mitigate issues of multicollinearity. This approach aims to determine whether the reduced-dimension data exhibit cluster distribution or scattered distribution.

The results of the PCA variance analysis, as depicted in the figure, reveal that the first two dimensions encapsulate 67% of the information, while the first three dimensions account for 87% of the information.

Consequently, Principal Components Analysis (PCA) was employed to reduce the data into two and three dimensions separately. By retaining the two and three principal components with the highest information content, it became feasible to compare the

characteristics between jurisdictions.

The results of the PCA variance analysis reveals that the first two components capture 67% of the information, and the first three components capture 87% of the information. Given this, we employed PCA to reduce data into two and three dimensions, respectively. By retaining the principal components with the highest information content, we were able to compare the characteristics between jurisdictions, using scatter plot diagrams (see Figure B.13). In both the two-dimensional and three-dimensional scatter plot diagrams, the red, blue, and green points exhibit distinct distributions, with each color forming its own cluster. Although the reduced components lack specific economic meaning, it is notable that many state characteristics exhibit a cluster distribution. Both the two-dimensional and three-dimensional scatter plot diagrams suggests that states governed by the same political party share similar economic and social characteristics. This is notably different from states governed by other parties. In summary, therefore, the PCA indicate a high level of cohesion within states governed by the same party in terms of their economic and social characteristics, while significant differences exist between states governed by different parties. This finding is consistent with Martin (2018)'s proposition that jurisdictions with similar features may have winners emerging from the bargaining game that are free riders, thereby predicting the outflow of funds from the winning coalition.

The scatter plot diagrams also show that republican states, democratic states, and swing states exhibit distinct cluster distributions in their respective areas. In the 2D plot presented, red and blue dots are situated on opposing sides, with swing states occupying the intermediary position. This configuration implies that any modifications to the grant formula favoring one party inflicts significant harm to the other. This observation may reflect opposition between the two parties during legislative bargaining, while swing states remain relatively indifferent. The distinctive nature of swing states is further highlighted in the 3D scatter plot, where green dots do not align. While it may not be surprising that traditional Republican states share similar social characteristics, the 3D scatter plot provides an alternative perspective on fiscal collective behavior within the Republican party. It raises the question of whether those who take part in the bargaining process act based on their political status or advocate for the benefits of the jurisdiction they represent. Hence, the preference effect may be mixed with the "free-rider" effect. To evaluate the effect of party preference, alignment and structure of different branches, the "free rider" effect should be carefully controlled.

In summary, the apparent collective alliance among ostensibly similar political parties

may be the result from the similarities in economic and social characteristics of states governed by the same political party. Hence, the PCA results underscores the need to establish a micro-foundation for any collective political behavior within a party. That is, it is essential to analyze the motivations of individual members rather than attributing it to collective group behavior.

3.5.2 Step 2: Fixed Effect Regression Analysis

To test the above four hypotheses, we employed a fixed effect regression analysis, a method ideally suited for panel data where multiple observations from the same entities (in this case, states) are observed over time. This approach allows us to control for unobserved heterogeneity that could bias our results, meaning it accounts for inherent characteristics of each state that do not change over time or are constant for each state across the study period. By focusing on the variations within each state, rather than between states, fixed effect models provide a more accurate estimation of the impact of political alignment and party preference on IGT distributions.

In preparation for the fixed effect regression analysis, we structured our panel dataset to include state-specific observations across multiple years, capturing the annual total amounts of IGT received by each state, along with the political party alignments at both the state and federal levels. The model included dummy variables for each state to capture unobserved, time-invariant characteristics. Independent variables of interest were lagged to address potential endogeneity concerns, ensuring that we capture the effect of prior political conditions on current IGT distributions. The regression equation was also augmented with time dummies to control for year-specific effects that might influence all states similarly, such as national economic conditions or federal policy changes. Standard errors were clustered at the state level to account for serial correlation within states over time. This comprehensive approach allowed us to examine the above hypotheses, while controlling for both observed and unobserved factors that could skew the results.

3.5.2.1 Data and Variables for Regression

Similar to the PCA, stratified sampling is also adopted. The sample states used when conducting the regression analysis are therefore the same as the ones used for the PCA. These were grouped into traditional Republican states, traditional Democratic states, and swing states. The dependent variable in the regression model is the annual total IGT amount received by state i . This variable was operationalized through logarithmic

transformation.

The independent variables include c , which is a dummy variable that represents alignment combination and p , which represent partisanship. More specifically, the dummy variable c represents the party distribution combination in the administrative and legislative branches across federal and state levels. Three key factors determine the nature of c : the governmental level, branch, and part. As depicted in Table A.11, these factors can be presented in a 2×2 table with two branches and two levels, resulting in four sectors. These sectors are denoted as u_1, u_2, s_1, s_2 . Each sector has two possible parties in control, namely the Democratic party " d " and the Republican party " r ".

In this study, the majority in the House of Representatives defines the partisan composition of the legislative branch, given its pivotal role in the budget-making process. The partisan composition of the administrative branch is determined by the partisan affiliation of the administrative leader, who could be the president or governor. There are 16 combinations in c :

$$(r, r, r, r), (r, r, r, d), (r, r, d, r), (r, r, d, d), (r, d, r, r), (r, d, r, d), (r, d, d, r), (r, d, d, d)$$

$$(d, r, r, r), (d, r, r, d), (d, r, d, r), (d, r, d, d), (d, d, r, r), (d, d, r, d), (d, d, d, r), (d, d, d, d)$$

We employ c_1, c_2, \dots, c_{16} to denote the 16 distinct combinations. In the regression analysis, only fifteen combinations are retained, with the omission of the first combination $c_1 = (r, r, r, r)$ to mitigate multicollinearity issues. c_1 serves as the benchmark in the regression model.

In the regression analysis, I incorporate a 1-time period lag of c as an independent variable. The rationale behind this is that the general decision-making process is time-consuming, implying that the effect of a specific party combination c should not be significant in the current year.

Regarding the dummy variable p , we gathered longitudinal data for three distinct types of states based on their political affiliations, including traditional Democratic states, Republican states, and swing states. The 14 states are categorized into three groups. The first group constitutes the traditional Republican states, often referred to as the "red wall states." We refer to this group as $p = 1$. The second group (referred to as $p = 2$) comprises traditional Democratic states, also known as the "blue wall states." The third group

(referred to as $p = 3$) represents swing states, commonly referred to as the “battleground states.”

The control variables encompass prevalent social and economic factors integrated into the distribution formula for federal grants projects. These factors, identified in the literature, can be inferred to have an impact on grants distribution and variables included can be listed in Table A.10. The variables that are included in the analysis covers the period from 2000 to 2019.

With panel data spanning 19 years, we adopt a fixed effect model approach to overcome potential omitted variables. In total, we develop and test the above hypotheses through three regression models. The benchmark model is an Ordinary Least Squares (OLS) regression with robust standard error. The second model is a time factor and individual factor fixed regression. The third model is an individual variable fixed model. The equations for these three models are as follows:

Model 1 - OLS Regression:

$$\begin{aligned} \log(igt_{i,t}) = & \alpha + \beta_1 c_{i,t-1} + \beta_2 p_{i,t} + \beta_3 \log(gdp) + \beta_4 \log(pl) + \beta_5 \log(mhi_{i,t}) \\ & + \beta_6 wapw_{i,t} + \beta_7 ur_{i,t} + \beta_8 \log(prm_{i,t}) + \epsilon_{i,t} \end{aligned} \quad (3.1)$$

For $t = 1, 2, 3 \dots T$ and $i = 1, 2, 3 \dots N$

Model 2 - Fixed effect model with time and state fixed:

$$\begin{aligned} \log(igt_{i,t}) = & \alpha_i + \theta_t + \beta_1 c_{i,t-1} + \beta_2 p_{i,t} + \beta_3 \log(gdp) + \beta_4 \log(pl) + \beta_5 \log(mhi_{i,t}) \\ & + \beta_6 wapw_{i,t} + \beta_7 ur_{i,t} + \beta_8 \log(prm_{i,t}) + \epsilon_{i,t} \end{aligned} \quad (3.2)$$

For $t = 1, 2, 3 \dots T$ and $i = 1, 2, 3 \dots N$

Model 3 - Fixed effect model with state partisanship controlled:

$$\begin{aligned} \log(igt_{i,t}) = & \alpha_i + \beta_1 c_{i,t-1} + \beta_2 p_{i,t} + \beta_3 \log(gdp) + \beta_4 \log(pl) + \beta_5 \log(mhi_{i,t}) \\ & + \beta_6 wapw_{i,t} + \beta_7 ur_{i,t} + \beta_8 \log(prm_{i,t}) + \epsilon_{i,t} \end{aligned} \quad (3.3)$$

For $i = 0, 1, 2 \dots N$.

3.6 Results

The regression results generated show that while all three models developed for this study exhibit high adjusted R-square values (0.835, 0.855, 0.791 separately) and the second model is superior to the other two models. It exhibits the highest adjusted R-square value. Moreover, with two factors fixed, it allows us to better control for omitted variables, which makes the significance of the coefficients more convincing. Given this, the subsequent analysis centers on the results generated from model 2 (see Table A.12, A.13 and A.14).

In model 2, seven coefficients are statistically significant at 5% significance level, including $c_2(0.00246)$, $c_3(-0.00751)$, $c_5(-0.0163)$, $c_6(0.0119)$, $c_{11}(0.00893)$, $c_{13}(0.00919)$, $c_{15}(-0.00713)$. In addition, the partisan variables “Democratic States” and “Swing States” are statistically significant.

The regression results support the hypothesis concerning unified government. That is, that a unified federal government is positively associated with higher overall IGT spending. A comparison of the coefficients of $c_5(r, d, r, r)$ and $c_1(r, r, r, r)$ reveals that a traditional Republican state, where both the administrative and legislative branches are controlled by the Republican party, experiences a 1.63% reduction in intergovernmental transfers proportion under bipartisan control at the federal level compared to a situation where the federal government is uniformly controlled by the republican party. This suggests that the federal government’s ability to distribute grants to states level is significantly constrained when the Republican party is not unified at the federal level.

As noted earlier, the coefficient of c_{16} in second model is deleted to overcome the multicollinearity problem. As such, we had to rely on the results generated from Model 1 and Model 3 when analyzing the second hypothesis. That, the hypothesis that political party color is related to the level of IGT spending. A comparison of $c_{16}(-0.006)$ and $c_1(0)$, suggest that states receive a 0.6% lower intergovernmental transfer when both the federal and state levels are controlled by the Democratic party, in contrast to a scenario where both levels are under Republican control. This suggest that a republican party preference is present for allocating more resources to state governments. However, c_{16} is not significant ($t = -1.65$) thus we cannot reject the null hypothesis that there is no difference between c_1 and c_{16} . Hence, the second hypothesis is not supported by our analysis.

The third hypothesis tested is that the level of political party alignment across the federal and state governments is positively related to IGT distributions. Our analysis offers statistically significant support for this hypothesis. When comparing the aligned

combination $c_1(r, r, r, r)$ and $c_3(r, r, d, r)$, the negative coefficient of c_3 indicates that unaligned states with a Republican-controlled federal government would receive fewer grants. Specifically, aligned Republican states receive 0.75% more grants compared to states with a Democratic governor. Another example of the alignment effect is the negative coefficient of c_{15} , which indicates that when a republic governor facing a democratic federal government, state government would receive 0.7% less in grants funds.

The final hypothesis tested is that battle ground (i.e., swing states) states are more likely to secure IGTs compared to non-battle ground states. Swing states receive significantly less in grant funding, compared to non-swing states. This contradicts hypothesis 4. One potential explanation is that, while swing states are crucial in determining election outcomes during election years, in nonelection years, the federal government may be reluctant to allocate additional resources to states controlled by opposing parties. The characteristics of swing states may lead the federal government to believe that it is not meaningful to appease swing states in non-election years.

In summary, the PCA analysis underscore the role of social and economic underpinnings in the unintended distribution of grants. Nevertheless, when the most impactful social and economic variables are controlled for in the two-factor fixed regression, two of the four hypotheses are supported, reaffirming the substantial influence of political party affiliations on grant allocations.

3.7 Review and Summary

This research examined the role of political party control in the distribution of intergovernmental transfers (IGTs) in the United States. Toward this end, we analyzed a panel data set spanning 19 years, using both PCA and fixed-effect regression models. The combination of these two methodological approaches allowed us to investigate the impact of political alignments on IGTs at both the state and federal levels, while controlling for relevant socio-economic factors. The analysis indicates that political congruence between state and federal governments plays a significant role in determining the flow of intergovernmental funds, with states aligned with the federal ruling party receiving favorable IGT allocations. This finding suggests that IGT allocation decision includes a strategic political dimension that transcends beyond mere economic and social needs.

The study is endowed with some limitation that needs to be considered when interpreting the data used in this study. These arise primarily as a result of the difficulties involved in gaining access to and collecting the data used in the study. One such limitation is

the limited time span of the data used in the study (19 years), which may reduce the robustness of our model. A second limitation arises from the fact that we employed the total amounts of IGTs received by states as dependent variables. As such, we were unable to distinguish between competitive grants and formula grants in the regression. This limitation may lead to some aggregation problems. For instance, the free rider effect may not be significant in competitive grants. Despite of these limitations, the study makes several contributions. First, it adds to an area of research that has received very limited attention—the role of political party control in IGTs. Perhaps most important, this study adds to this limited body of research by illuminating the intricate relationship between political affiliations and IGT distributions, highlighting the important role that political considerations may play in this process.

Another important contribution of this study is that it may also serve to inform prior research findings discourse related to the so-called flypaper effect. The flypaper effect posits that an increase in grants-in-aid lead to significantly higher public spending compared to the same increase in private income, causing funds to “stick where they hit” (Inman, 2008). Scholars attribute this phenomenon to various causes. Hamilton, for instance, attempted to explain the flypaper effect as a result of improper data distinction or empirical methods (Hamilton, 1986), while others associate the flypaper effect with fiscal illusion (Gramlich, 1997c). This research may be viewed as a novel perspective to explain the flypaper effect. The confirmed political factor impact during IGT distribution suggests that: for certain states, obtaining grants from the federal government is easier compared to generating revenue through other means. This relative price effect may explain the inclination of state governments to prefer raising funds from IGTs rather than through taxation. Following this logic, the magnitude of the flypaper effect should be influenced by the partisan distribution between the central and state governments. States that are prone to free-riding or are favored by a central government may experience a greater flypaper effect, as grants for such subnational entities are relatively easier to obtain, amplifying their spending tendencies.

Chapter 4 |

Effect of Intergovernmental Transfer on Local Governments' Spending Behavior

Chapter 4 marks a pivotal transition in our exploration of fiscal federalism, shifting the lens to the specific impacts of transfer payments on local government fiscal behavior, including public spending actions and revenue collection behaviors. Prior to delving into the core analysis, it is imperative to contextualize our investigation within the existing scholarly landscape. The literature on transfer payments' effects is rich and diverse, generally bifurcated into studies examining inter-jurisdictional impacts and those focusing on the fiscal behavior of local governments themselves, summarized as Figure B.15. The top side of Figure B.15 focuses on the topic of transfer payments' impacts across regions, while the lower side concentrates on the effects on subnational governments' own fiscal behaviors, which are further divided into fiscal expenditure behavior and fiscal revenue behavior. For example, the topic across regions may include: the role of transfer payments in influencing revenue equity and their role in enhancing fiscal equity across regions. This latter category, which forms the crux of Chapters 4 and 5, is further divided based on the nature of fiscal behavior under examination: public spending (Chapter 4) and tax collection activities (Chapter 5).

Chapter 4 of this dissertation critically examines the impact of intergovernmental transfers on the spending behavior of local governments, specifically through the lens of the "flypaper effect." This analysis is pivotal to the dissertation's overarching goal of delineating the intricate web of fiscal interactions and their implications within the fiscal federalism framework. By systematically reviewing the literature and employing a mathematical model to investigate how these transfers influence local expenditure

decisions, this chapter contributes to a deeper understanding of the behavioral dynamics at play within fiscal federalism. It highlights the nuanced ways in which federal grants affect local spending priorities and practices, thus providing essential insights into the efficiency and effectiveness of resource allocation across government tiers. This exploration not only enriches our theoretical knowledge of fiscal federalism but also offers practical guidance for policymakers aiming to optimize public goods provision through strategic intergovernmental transfers. Consequently, the findings and discussions presented in this chapter enhance the comprehensive analysis of fiscal strategies explored throughout the dissertation, reaffirming the significance of understanding fiscal behaviors in achieving equitable and efficient public service delivery.

In Chapter 4, I conduct a comprehensive review of literature related to the effect of intergovernmental transfer on subnational government spending, with a key focus on systematically categorizing explanations for the flypaper effect observed in previous studies. Recognizing a gradual deepening in scholars' understanding of the flypaper effect, we divide this evolution into three stages. In addition, by developing and refining a model to simulate the specific causes behind the flypaper effect, we offer a mathematical representation that allows for its visualization, enabling an intuitive observation of changes in the effect's magnitude.

4.1 Fungibility and Flypaper Effect

One intuitive philosophy about the effect of IGT on subnational government spending is called "fungibility" (Pack & Pack, 1993), which means the intergovernmental transfer received by local government would substitute the local government's revenue. Recipients assimilate federal funds into general revenue and reduce the spending on public goods through a reduction of local taxes within the jurisdiction. However, supportive empirical evidence are quite limited. On the contrary, evidence on flypaper effect is widespread everywhere.

The flypaper effect is widely regarded as the most influential phenomenon in the fiscal federalism literature regarding the vertical transfer of funds from the federal to the state or local level (Gamkhar, 2007; Hines Jr & Thaler, 1995). According to Bradford and Oates' model, a lump sum grant to the state or local level should have the same effect as an increase in individual revenue within the jurisdiction in terms of stimulating public expenditure (Bradford & Oates, 1971). This conclusion is known as the equivalence theorem, which is based on two fundamental assumptions: the median voter theorem and

lump-sum tax collection by federal, state, and local governments. However, empirical evidence does not support this theorem. Specifically, some researchers have found that a \$1 increase in individual revenue leads to an increase in public expenditure of only \$0.02 to \$0.05, while a \$1 increase in intergovernmental transfers can lead to an increase in public expenditure of \$0.25 to even \$1 (Bailey & Connolly, 1998; Dollery & Worthington, 1996; Gamkhar, 2007). This phenomenon is known as the flypaper effect. According to Inman's statistics, over 3,500 research papers have investigated the flypaper effect, both theoretically and empirically (Inman, 2008).

In this section, I'm summarizing how scholars in different stages explain the flypaper effect. The understanding of flypaper effect went through a incremental progress, though may not be chronologically. This progress can be identified as three phrases. In the first stage, the conventional analysis, scholars believe the matching grants have both price effect and income effects while the non-matching grants is analogous to the lump-sum subsidy, which means only income effects exists. In second stage, some scholars start to realize that non-matching grants has price effects as well, but that's due to the impact of fiscal federalism setting and fiscal illusion. Federal government collecting revenue then redistributing to state and local generates fiscal illusion since this process is too complicated for consumers to perceive. In third stage, scholars start to realize the effect of distortionary tax that collect by grants recipient. The distortionary tax policy together with the low administrative efficiency in state and local leads to a higher marginal cost of the tax collection. Hence no matter the grants is matching or non-matching, the state or local government trend to use the grants rather than the tax revenue to cover the expenditure.

The investigation on flypaper effect in my view can be divided into 3 phrase from the shallower to the deeper.

4.2 Literature on Flypaper Effect

4.2.1 Phrase One

Except for the introduction of intergovernmental transfer in figure B.10, one important concern about IGT in economic analysis is the matching mechanism. For matching grants, federal governments will reimburse a specific ratio for each 1 dollar of state and local expenditure. Based on whether federal government set a cap on the matching grants, matching grants can be divided into open-ended matching grants and closed-ended grants.

As is shown in figure B.16, the two parallel lines L_1 and L_3 are budget constraint of the economy before and after the non-matching grants and L_3 is the budget constraint with matching grants which is the red line. The difference between G_m and G^* is the combination of price effect and income effect of matching grants.

The matching grants model explains why scholars in first stage explain the fly paper effect by misspecification or omitted variable. Misspecification refers to instances where researchers may conflate matching grants with lump-sum grants, leading to a mix-up of price effects and subsequently resulting in increased public goods spending (Henderson, 1968; Lankford, 1987). Matching grants reduce the marginal price of public services, thus mix-up with lump-sum grants would lead to an increase in public goods spending (Gramlich, 1997b). Some scholars attribute the flypaper effect to omitted variables or pre-selection issues. Knight (2002) developed a two-level bargaining model to demonstrate that the federal government distributes intergovernmental transfers to states and local governments with a higher propensity to spend, indicating that the flypaper effect is not a result of intergovernmental transfers. However, prior studies and investigations have encountered endogeneity issues. To address this, Knight conducted an empirical test where he employed an instrumental variable to control for the endogeneity problem. His results indicate that once the pre-selection issue is filtered out, the flypaper effect is not evident, at least for the data he collected regarding interstate highway programs. To summarize, the understanding under this view is that the flypaper effect may not actually exist, but may instead be a result of misspecification or omitted variables.

4.2.2 Phrase two

The literature on the flypaper effect has also been approached from a second perspective, whereby scholars recognize the importance of lump-sum grants and their potential price effects. While scholars in the first stage focused on the price effects of matching grants, it was realized that this may not be sufficient to explain the large gap in the flypaper effect. As such, the second stage of literature argues that non-matching grants also have price effects, which can be attributed to fiscal illusions. McCulloch (1845) argued that taxpayers often misperceive the costs of governmental activities, a concept later summarized as fiscal illusions. The theory of fiscal illusion was first developed by Italian economist Puviani (1903) in his 1903 book *Teoria della illusione finanziaria*. Wagner (1976) introduced this concept in America and identified the effect of fiscal illusions on local government spending. Borge (1995) and Oates (1979) also recognized the potential price effect of non-matching grants and attempted to explain it using the concept of

fiscal illusions. The lower-estimated public good price generates an even flatter slope of the budget constraint compared to the L_3 in figure B.16.

The existence of fiscal illusion can be attributed to administrative factors and institutional intention. The fiscal federalism framework is complex and difficult for residents to comprehend, while administrative processes are often opaque and lack transparency, preventing residents from understanding the nuances of intergovernmental grants and their own contributions to these grants. Empirical research by Turnbull (1998) supports this view, demonstrating that imperfect information generates a broader fiscal illusion based on municipal data. Additionally, the budget-maximizing tendencies of bureaucratic systems are supported by both empirical evidence and theoretical inference (Brennan & Buchanan, 1977; Mueller et al., 2003). This tendency is sometimes referred to as "Leviathan government," in which governments seek to maximize their budgets rather than prioritize residents' utility (Quigley & Rubinfeld, 1986). The combination of budget-maximizing bureaucrats and lower perceived prices of public goods leads to increased expenditure on public goods.

4.2.3 Phrase Three

In stage three, scholars have also examined the effect of the cost of tax collection within a jurisdiction. This cost can arise from two aspects, one being the distortionary tax, another one comes from the revenue collection ability of the sunational government. Assuming that tax revenue collection does not cause any distortion for the recipient is a strong assumption. In reality, changes in state and local government tax policies can significantly alter residents' behavior. For instance, if residents are dissatisfied with tax and public goods policies, they may choose to work less and spend more time on leisure. Alternatively, they may move to another jurisdiction, which itself incurs costs due to the tax increase. Hamilton (1986) was the first to observe that the cost of tax collection within a jurisdiction leads to a curved budget constraint, rather than a straight line. However, his idea was not widely accepted at the time, and he neglected to consider administrative ability as a source of cost, focusing only on deadweight loss as the source of tax collecting cost.

In reality, the cost of tax collection comes from various sources, including the different levels of administrative ability between federal and state governments. Volden (2007) developed a game theory model to simulate the interaction between the federal government and lower-level governments and showed that the different costs of collecting revenue for federal and state governments partially explains the flypaper effect. Dahlby and Ferede

(2016) argued that the price effect of non-matching grants exists even without fiscal illusion due to subnational governments face information and ability disadvantages, meanwhile Vegh and Vuletin (2016) came to a similar conclusion. In summary, these researchers suggest that the collection of tax revenue is costly for state and local governments due to factors such as administrative inefficiency and distortion, leading to a preference for using "cheaper" resources such as intergovernmental transfers. Therefore, even non-matching grants or lump-sum grants can have price effects.

Some horizontal government interaction explains this distortion as well, Brueckner (2003) develops a strategic model to analyze the state and local fiscal behavior, he concludes that the lower-level governments are quite sensitive to other competitors. This sensitivity may explain why state and local government don't want tax increase revenue to cover the public goods. Other horizontal interaction theory such as yardstick competition or tax competition also explains the sensitivity.

I expand the benchmark model by introducing the distortion of tax collection into it.

4.3 Mathematical Expression of Flypaper effect

Following the comprehensive literature review on the flypaper effect, the next step involves developing a mathematical model to simulate this phenomenon. Beginning with foundational assumptions where the flypaper effect is initially absent, the model progressively incorporates a variety of taxes and refines utility functions to provide a clear and explicit explanation of the reasons behind the flypaper effect. This approach aims to elucidate the underlying mechanics of the effect, offering a theoretical framework that enhances our understanding through a step-by-step augmentation of model complexity.

4.3.1 Benchmark model

The Benchmark model is similar to Vegh and Vuletin (2016)'s benchmark model with small modification.

To make the benchmark model as straight forward as possible while capture the IGT mechanism. I assume that:

1. Economy is static.
2. Only one local government and representative citizen in this economy.
3. Two kinds of goods in the economy which are public good G and private good X .

4. Resident spend all there income y , which is given, on either private goods X or tax τ .
5. The tax is lump-sum tax with no dissertation.
6. Source of government revenue: tax τ and transfer f .
7. Type of transfer: Nonmatching grants,like lump-sum subsidy.

The representative citizen's budget constraint is:

$$y = X + \tau \quad (4.1)$$

The local government's budget constraint is:

$$f + \tau = G \quad (4.2)$$

Combine equation 4.1 and 4.2, I get a budget constraint for the economy:

$$y + f = X + G \quad (4.3)$$

The utility for representative resident comes from the utility of X and G . I assume the utility function is the Cobb-Douglas form thus it's a concave utility:

$$U(X, G) = AX^\alpha G^{1-\alpha}, 0 < \alpha < 1 \quad (4.4)$$

For the representative resident, the problem is to choose proper level of X to maximize the utility in equation 4.4 subject to equation 4.1. The Lagrangian equation can be set up as:

$$L(X) = AX^\alpha G^{1-\alpha} + \lambda_{rc}(y - X - \tau) \quad (4.5)$$

Solving the equation 4.5 will get first order condition(foc):

$$\alpha A \left(\frac{X}{G} \right)^{\alpha-1} = \lambda_{rc} \quad (4.6)$$

$$y = X + \tau \quad (4.7)$$

To solve the Ramsey problem, the Ramsey planner needs to decide the level of X, G

to maximize the utility subject to equation 4.3 and equation 4.2. The Lagrangian can be set as:

$$L(X, G) = AX^\alpha G^{1-\alpha} + \lambda_e(y + f - X - G) + \lambda_{lg}(f + \tau - G) \quad (4.8)$$

Solving the equation 4.8 will generate:

$$\alpha A \left(\frac{X}{G} \right)^{\alpha-1} = \lambda_e + \lambda_{lg} \quad (4.9)$$

$$(1 - \alpha)A \left(\frac{X}{G} \right)^\alpha = \lambda_e + \lambda_{lg} \quad (4.10)$$

$$y + f = X + G \quad (4.11)$$

$$f + \tau = G \quad (4.12)$$

Combining equation 4.9, 4.10, 4.11 will generate:

$$(1 - \alpha)y + (1 - \alpha)f = G \quad (4.13)$$

The flypaper effect definition can be mathematically expressed as $\frac{dG}{df} - \frac{dG}{dy}$. Given equation 4.13, the flypaper effect $fe = 0$, which means, under this setting, theoretically there should be no flypaper effect.

4.3.2 Ramsey Model with Distortionary Tax Collection

To capture the distortion effect of the tax, I loosen the 3rd and 5th assumption of the benchmark model. I follow the setting by Vegh and Vuletin (2016) by adding a taxable private goods X_t to differentiate with the non-taxable private goods X_{nt} and capture the distortion effect of proportional tax. In reality, X_{nt} could express any behavior that representative resident take to avoid the taxation, such as more time on leisure or The assumption on taxation and representative resident's spending behavior are:

1. Three kinds of goods in the economy which are public good G and taxable private good X_t and non-taxable private good X_{nt} .
2. Resident spend all their income y , which is given, on either taxable private goods X_t , non-taxable private goods X_{nt} or tax.

3. The tax is proportionary tax on X_t , with tax rate θ .

So the budget constrain for resident, local government and the whole economy could be separately list as:

$$y = X_t(1 + \theta) + X_{nt} \quad (4.14)$$

$$f + \theta X_t = G \quad (4.15)$$

$$y + f = x_t + x_{nt} + G \quad (4.16)$$

Different from Carlos' setting who accept a more general setting on residents' and governments' utility, I set Cobb-Douglas form on utility to get a arithmetic solution. Unlike the benchmark model in Carlos' research, in which he set the linear utility, the Cobb-Douglas setting means the imperfect substitute between private and public goods, which is a more reasonable setting. The distribution on X_t , X_{nt} and G should maximize representative resident's utility and government's utility.

$$\begin{cases} U = AX^\alpha G^{1-\alpha} \\ X = BX_t^\beta X_{nt}^{1-\beta} \end{cases} \quad (4.17)$$

Where X represent a compound private good.

For resident, they need to decide X_t, X_{nt} to maximize U subject to equation 4.14. For local government, the problem is to decide the distribute of X and G to maximize U , thus the Ramsey problem is to maximize both resident and local governments' utility, which is listed as equation 4.17 subject to equation 4.14 and 4.15. For resident, the first order conditions on $X_t, X_{nt}, \lambda_{rc}$ can be listed as:

$$\frac{\partial U}{\partial X} \frac{\partial X}{\partial X_t} = (1 + \theta) \lambda_{rc} \quad (4.18)$$

$$\frac{\partial U}{\partial X} \frac{\partial X}{\partial X_{nt}} = \lambda_{rc} \quad (4.19)$$

$$y = X_t(1 + \theta) + X_{nt} \quad (4.20)$$

Solving equation 4.18, 4.19 will generate the relationship between X_t and X_{nt} in equilibrium and the level of θ :

$$X_{nt} = \frac{(1 - \beta)(1 + \theta)}{\beta} X_t \quad (4.21)$$

$$\theta = \frac{\beta X_{nt}}{(1 - \beta)X_t} - 1 \quad (4.22)$$

For local government and Ramsey Planner, they need to decide G, X_t, X_{nt} subject to equation 4.15 and 4.16, the FOCs on $X_t, X_{nt}, G, \lambda_e, \lambda_{lg}$ are:

$$\frac{\partial U}{\partial X} \frac{\partial X}{\partial X_t} = \lambda_e + \lambda_{lg} \quad (4.23)$$

$$\frac{\partial U}{\partial X} \frac{\partial X}{\partial X_{nt}} = \lambda_e + \frac{\beta}{1 - \beta} \lambda_{lg} \quad (4.24)$$

$$\frac{\partial U}{\partial G} = \lambda_e + \lambda_{lg} \quad (4.25)$$

$$y + f = x_t + x_{nt} + G \quad (4.26)$$

$$f + \theta X_t = G \quad (4.27)$$

Solving equation from 4.23 to 4.27, I can get the arithmetic solution of X_t, X_{nt}, G as:

$$x_t = \frac{\beta y + f}{\alpha\beta + 1 - \alpha} \cdot \alpha\beta \quad (4.28)$$

$$G = \frac{(\beta y + f)(1 - \alpha)}{\alpha\beta + 1 - \alpha} \quad (4.29)$$

Follow the definition of *fe* in benchmark model , the flypaper effect under distortionary taxation can be calculated as:

$$\frac{dG}{df} - \frac{dG}{dy} = \frac{(1 - \alpha)(1 - \beta)}{\alpha\beta + 1 - \alpha} \quad (4.30)$$

To get a visual impression about the size of flypaper effect under distortion, I generated a 3-D figure based on equation 4.30 through Mathematica.

From figure B.18, one obvious fact to be noticed is that the flypaper effect under distortion is always positive, no matter what the value of α and β is. More implication can be found when we pin down one of α and β and evaluate the fluctuation of flypaper effect on the other.

Figure B.20 are cross sections of Figure B.18 when $\alpha = 0.1, 0.4, 0.7, 0.9$ separately. It can be explained from two aspects. For one, the size of flypaper effect is negatively related with β for given *alpha*. In other words, the more citizens value taxable private

goods X_t , the less fly paper effect should be. Potential explain behind is that, higher β means citizens attach great importance to the taxable private goods, thus the tax on X_t doesn't change citizen's allocation on X_t and X_{nt} . In this circumstances, collecting tax to support public goods is not that "expensive" compared to general transfer. So the stimulative effect gap between IGT transfer and private income increase is trivial.

Besides, the elasticity of FE on β is affect by α . As α gets higher, the relationship between FE and β shifts from a linear relationship to a convex relationship.

α is also negatively related to FE . A greater α means the greater marginal utility on private goods. In short, when citizens care more about private goods rather than public goods, the fly paper phenomenon is relatively less significant. One explanation is, when citizens gain more utility from private goods, government should alleviate the tax burden since less public goods is necessary, thus lead to less distortion. Another obvious suggestion is as β gets higher, the function of FE on α gradually evolve into a linear function from a concave function.

4.4 Summary: About the Reason of Flypaper Effect

Together with some proposition I get from chapter 2 and the literature I went through in this chapter, I can have a summary about the reason of flypaper effect.

The genesis of the flypaper effect, apart from the statistical categorization confusion between matching and non-matching grants highlighted in the initial phase of literature review, can largely be attributed to various manifestations of price effects, albeit originating from distinct sources. Primarily, the discrepancy in cost perception between transfer payments and tax levies, driven by fiscal illusion and tax aversion, predisposes citizens towards a preference for transfer payments over taxation. This predilection of the populace is mirrored in the fiscal policy choices of local governments. To elucidate, fiscal illusion leads to an underestimation of the personal cost embedded within transfer payment policies by the citizens, while tax aversion results in an overestimation of the personal cost entailed in tax collection policies, culminating in the price effect that gives rise to the flypaper effect.

Another vector for the price effect is the distortionary impact of taxation, as expounded upon in Section 4.3 of this chapter. When alterations in the tax regime modify consumer or saving behaviors, thus inducing distortions, local governments perceive these distortions as cost factors. Consequently, compared to tax collection, local governments exhibit a marked preference for transfer payments as the financial underpinning for public goods

provision.

Lastly, this price effect may also stem from variances in tax collection efficiency. As delineated in Proposition 9 of Chapter 2, a divergence exists between the tax collection efficiencies of local and central governments, potentially attributable to two dimensions: the magnitude of tax distortions and the disparities in public administration competencies. Initially, in contrast to local governments, the central government may inflict lesser distortions in collecting certain types of taxes. For instance, levying consumption or property taxes may incentivize cross-state consumption or relocation activities among residents, yet considerations for international consumption and relocation tend to be overlooked. Furthermore, the central government may possess superior public administration capabilities in tax collection, as evidenced by the establishment of a comprehensive tax collection infrastructure, the employment of more specialized tax collection personnel, and a larger cadre of tax officials.

4.5 Policy Implication

Chapter 4's exploration into the flypaper effect and its determinants underscores several key considerations for policymakers and public administration professionals. The empirical and theoretical analyses presented reveal that the response of local governments to intergovernmental transfers is not merely a matter of fiscal mechanics but is deeply influenced by the perceptual and behavioral dynamics of both the governing bodies and the populace they serve.

- Designing Targeted Transfer mechanisms

Policymakers should prioritize the crafting of intergovernmental transfer mechanisms that account for the underlying causes of the flypaper effect identified in this study. Recognizing the role of fiscal illusion and tax aversion, transfer policies need to be transparent and communicated effectively to mitigate misperceptions about the cost and benefits of public spending and taxation.

- Improving Public Administration competencies

The divergence in tax collection efficiencies between different levels of government highlighted in the chapter calls for initiatives to bolster the administrative capabilities of local governments. Investment in training for tax officials, the adoption of advanced tax collection technologies, and the establishment of comprehensive fiscal management systems are critical steps towards this end.

- About the Scale of Flypaper Effect

To be frank, the models provided in this paper are not sufficient to precisely calculate the scale of the flypaper effect; neither 3D nor 2D graphs can serve as accurate graphical representations of data. However, the content of this chapter adequately allows governments to have an intuitive understanding of the factors influencing the magnitude of the flypaper effect and offers explanations for the varying scales of the flypaper effect as shown in empirical evidence. In the analysis presented in this paper, several factors impact the size of the flypaper effect. Firstly, as reflected in Proposition 8 of Chapter 2, states with high output and tax bases exhibit a different magnitude of the flypaper effect compared to states with low output and tax bases; secondly, the tax collection efficiency of different governments also affects the scale of the flypaper effect; lastly, its magnitude also depends on the consumer sector's demand for taxed and untaxed goods and the demand for private versus public goods.

Chapter 5 |

Effect of Grants Restriction on Subnational Governments' Revenue Collection Effort: a Kalman Filter Application

5.1 Introduction

The relationship between intergovernmental transfers and local governments' tax collection behaviors is pivotal in understanding fiscal dynamics and its consequences on public expenditure patterns. This study investigates whether local governments adjust their tax efforts—either increasing or decreasing them—in response to intergovernmental transfers, and how these adjustments are influenced by any constraints attached to the transfers, such as specific spending requirements. This inquiry is crucial as it affects the overall tax burden within local jurisdictions, potentially influencing population and capital mobility, which may or may not align with federal objectives. Previous literature primarily examines the relationship between intergovernmental grants amounts and tax collection effort, paying less attention to how spending restrictions attached on these grants influence tax efforts. Within the discussion on the effect of total transfer amounts, the empirical evidence on tax collection efforts remains mixed. Some studies suggest that transfers reduce income disparities, decreasing the need for aggressive tax collection, while others argue for an opposite effect. This discrepancy in findings could stem from two main challenges: a lack of formal theoretical foundation in prior analyses and the difficulty in observing and accurately measuring tax collection efforts.

To address these gaps, this chapter reviews existing literature to outline a comprehensive analytical framework that explicates the underlying mechanisms at play. It utilizes the Kalman filter to refine the measurement of tax collection efforts and conducts a panel data analysis to empirically test the theoretical predictions. The objective is to develop a theoretical model that clarifies the impact of intergovernmental transfers on tax efforts and empirically validate this model, enhancing our understanding of fiscal policy's role in local government behavior.

Chapter 5 represents a pivotal segment of this dissertation by examining the influence of grant restrictions on the revenue collection efforts of subnational governments, thereby addressing a crucial aspect of fiscal federalism—the impact of intergovernmental transfers on local fiscal autonomy and efficiency. This chapter directly ties into the dissertation's broader aim of dissecting the multifaceted interactions between central and subnational governments and their implications for public goods provision and fiscal sustainability. Through the innovative use of a Ramsey model complemented by Kalman filter estimation, this study not only contributes to a deeper theoretical understanding of the mechanisms underpinning fiscal federalism but also offers empirical insights critical for policy formulation. By distinguishing between the effects of general and categorical grants on tax collection efforts, Chapter 5 elucidates the nuanced ways in which different types of intergovernmental transfers can either incentivize or disincentivize local tax effort. This investigation enriches our comprehension of the strategic fiscal behaviors that characterize the relationships within fiscal federalism, thus enhancing the overall narrative of the dissertation by highlighting the importance of grant design in fostering an equitable and efficient provision of public services across government tiers.

The chapter is structured as follows: It begins with an overview of tax effort and its significance to actual tax burdens, followed by a review of the relevant literature. It then details the theoretical model and hypotheses, and employs a panel data model to test these hypotheses, aiming to contribute to a more nuanced understanding of the fiscal interplay between different levels of government.

5.2 Background

The background information section will aim to introduce the concept of tax effort and its relationship with the actual tax burden. It will facilitate the subsequent discussion on whether using the actual tax burden as a measure of tax effort in the existing literature is justified.

The concept of tax effort plays a critical role in fiscal policy analysis, bridging the gap between legal tax rates and the actual tax burden experienced by citizens. Unlike the statutory tax rates, which are often rigid due to legislative processes, tax effort reflects the discretionary practices of subnational governments to manage their revenue collection without altering the legal tax framework. For example, while the United States Congress has the authority to modify federal tax rates, local administrations may employ various strategies, such as offering tax incentives or enforcing different degrees of compliance rigor, to effectively adjust the tax burden on their constituents.

This nuanced approach allows subnational entities to respond to fiscal transfers from higher levels of government and other economic variables without needing formal tax legislation adjustments. Tax effort, therefore, encapsulates the extent to which local governments exploit their tax base, considering the limitations imposed by their administrative and legal frameworks. It encompasses actions like granting tax reliefs, managing exemptions, and varying the intensity of tax collection efforts, all of which affect the actual tax rate applied to the economy.

Understanding the dynamic between tax effort and the actual tax burden is essential for analyzing fiscal policy's impact on economic behavior and public finance. It highlights the importance of administrative discretion in tax collection and the need for analytical models that can accurately capture these subtleties. This paper aims to contribute to this understanding by proposing a theoretical framework and empirical analysis that account for the complexities of tax effort and its determinants, setting the stage for a deeper investigation into how intergovernmental transfers influence these efforts.

5.3 Literature Review

In this section, we delve into the existing literature on the relationship between intergovernmental transfers and tax efforts, aiming to dissect the theoretical perspectives and empirical findings that characterize this field. Our goal is to synthesize the main trends, critical insights, and remaining gaps within this area of study, thereby laying a solid foundation for understanding the current state of research and identifying avenues for future investigation.

Our literature review is structured into two principal segments:

Firstly, we will explore both theoretical and empirical studies that examine the impact of intergovernmental transfers on local government tax efforts. This includes analyses that investigate the potential for transfer payments to substitute for local revenue collection

efforts (diminishing tax effort), as well as studies that suggest circumstances under which transfers might encourage the expansion of the tax base. By integrating these bodies of work, we aim to highlight the dominant arguments and findings in the field, noting the congruences and discrepancies between theoretical predictions and empirical observations.

Secondly, we will delve into the specific challenges and issues encountered in empirical research within this domain. This segment will emphasize the key difficulties faced by researchers, such as data constraints, methodological choices, and accurately assessing the effect of intergovernmental transfers on tax efforts. By examining these challenges, we seek to reveal the critical questions that future research must address to deepen our understanding of the dynamics between intergovernmental transfers and tax efforts.

Through this organizational approach, we aspire not only to summarize and critique the significant contributions of the existing literature but also to highlight the direction for our studies. This classification facilitates a clear distinction between theoretical expectations and empirical validations, emphasizing the gaps and challenges present in current research. This sets the stage for the subsequent parts of our study, where we will first thoroughly investigate the theoretical and empirical research on the impact of transfers on tax efforts before turning our attention to the major issues and challenges encountered in empirical stud

5.3.1 Theoretical and Empirical Insights on Intergovernmental Transfers and Tax Effort

Inherent to the nature of general transfer is that transfer would lead to tax fungibility effect, which means transfer would substitute local governments' revenue collection efforts. This phenomenon is also referred to as the crowding out effect on tax effort and has been supported by bunch of evidences (Inman, 1988; Litvack et al., 1998; Peterson, 1997). Empirical evidence in both developed and developing countries has further confirmed this theoretical inference. For example, Nicholson Nicholson-Crotty, 2008 discovered the fungibility effect of intergovernmental transfer on tax effort at the state level in Germany and the United States. Baretti et al. (2002a), Aragón and Gayoso (2005), Panda (2009), Mogues and Benin (2012), and Bravo et al. (2013) found similar evidence in developing countries such as Peru, India, Ghana, and Chile. In short, the fungibility of intergovernmental transfer on tax revenue could lead to a decrease in the efforts of governments to collect tax revenue once they receive sufficient funds from transfer payments.

The fungibility effect seems natural when the range of study is constrained in one specific jurisdictions. Once multiple jurisdictions and horizontal competition are introduced into the consideration, one opposite impact also seems to be reasonable. Some theoretical research contend that the local jurisdictions should be motivated to lower the tax burden since they are facing the tax competition. The lower tax burden may attract capital, citizen or enterprise into the area, thus the local governments may actively give up the tax benefits they could have collected. In another word, the tax competition may encourage the local governments to expand the tax base rather than increase the tax effort. The revenue from intergovernmental transfer may neutralize this subjective intention, thus the tax effort would be positively affected.

Bucovetsky and Smart (2010), Buettner (2006a) describe this guess in their analysis of fiscal equalization. Liusupa/Supsup*/Sup and ZhaoSupb/Sup (2011) found some empirical evidence in China. Compared to the study on fungibility, the investigation on this effect are seldom systemically investigated in theoretical level, limited literature are empirical analysis.

5.3.2 Empirical Challenges and Insights in Assessing Transfer Effects on Tax Effort

Nicholson-Crotty (2008) did a fixed regression and assert that the grants-in-aid exert downward pressure on state tax effort. Dash and Raja (2013) get opposite evidence and find stimulative effect on tax collect efficiency. Brun and Khidari (2016) research on the effect of categorical grants in Morocco failed to yield a conclusive result, which they attribute to political influence, leaving ample room for local governments to negotiate. One natural question is: unlike general transfers, when central government confine the transfer to a specific area, what is the possible impact on local governments' tax collection effort?

In the empirical investigation related to tax collection effort, a common challenge is the measurement of the tax collection effort since it's unobservable. There are two common methods for former researchers to overcome this issue. One is the average tax ratio method and another is potential tax revenue method.

The average tax ratio is to find an observable variable to express the tax collection effort and substitute the real tax effort (Luo & Douglas, 1996; M. V. Tanzi et al., 1981). However, the defect of this method is obvious. The usefulness of this method depends on the quality of the substitute variable. For example, Lv and Zhang (2018) use the actual

tax burden of the companies in China as the proxy of tax effort, however no one can conclude that the actual tax burden is a good proxy. Kim (2007) also points out that the average tax ratio cannot control all other factors affecting the proxy variable.

The potential tax revenue method is to estimate or predict the potential tax revenue based on the variables affecting tax revenue. This way to predict the tax revenue is called tax handle method (Martinson, 1968). Next step is to compare the actual tax revenue with the predicted value. For example, Dalamagas et al. (2019) use the auto-regression model to estimate the tax effort in european countries. Such method is used in both developing and developed countries(Eltony, 2002; Gupta, 2007; Piancastelli, 2017). However the potential tax revenue method is a biased estimator according to Kim (2007)'s proof steps. To overcome the deficits of these two methods, Kim (2007) points out that the Kalman filter is the best estimator to estimate the unobservable tax collection effort. He also proved the superiority of the Kalman filter estimator through a Monte Carlo process.

After the adoption of the kalman filter, some most recent work on estimating the tax collection effort gets better estimation of the tax collection effort. Thomas and Maynard (2010) updated the estimation of tax collection effort by a kalman fiter with the data of Barbados. With better estimation, the understanding about how to narrow fiscal deficiency in Barbados got further progress. But this method are commonly used as an estimator to measure the actual tax collection effort of national economy while is seldom used to measure tax collection effort of the subnational economy (W. et al., 2007). So far the kalman filter has not been used to push the understanding the relationship between intergovernmental transfer and tax collection effort.

5.3.3 Review and Summary on Literature Review

Synthesizing the aforementioned literature, several key characteristics emerge within this domain.

The majority of discussions center around the total volume of intergovernmental transfers, examining how increases or decreases in transfer amounts affect local government tax efforts. Conversely, there is relatively less discussion on how other characteristics of intergovernmental transfers influence tax efforts. For instance, there is limited exploration of how grants with restrictions, such as categorical intergovernmental grants, affect tax efforts compared to general intergovernmental transfers. Such inquiries are comparatively underexplored.

Within the limited discussions on the impact of specific intergovernmental transfers

on tax efforts, conclusions often vary, making it challenging to establish a unified stance(Chubb, 1985; Gramlich, 1997a; Nicholson-Crotty, 2004). This phenomenon can be attributed to two main reasons. Firstly, existing studies predominantly rely on empirical analyses, with limited rigorous theoretical deductions. Moreover, significant disparities exist among the economic, social, and administrative realities in the sample countries, leading to inconsistent empirical findings without comprehensive theoretical explanations. Secondly, due to the unobservability of tax effort, many studies substitute proxy variables for tax effort in regression analyses, thereby compromising the effectiveness of estimators.

While scholars have attempted to address the unobservability of tax effort by employing new econometric tools such as the Kalman filter, these methods have primarily been used to assess tax efforts at the national level, overlooking their application to local administrative entities within nations. Consequently, the use of such methods has yet to establish a link between tax effort and intergovernmental transfers at the sub-national level, as intergovernmental transfers are predominantly absent at the national economic level.

To address the identified gaps in the literature, I set up a one-period Ramsey problem in this study to analyze the tax collection behavior of subnational governments when received categorical transfer. To further validate the theoretical inferences, empirical investigation was conducted. Specifically, I employs the Kalman filter to assess tax efforts across various states in the United States, thereby providing evidence on the impact of specific intergovernmental transfers on tax efforts within a panel data framework.Compared to the research in this area, my investigation get implication on both general transfer and categorical transfer. The utilization of both qualitative and quantitative methods in this study allowed for a solid understanding of the research topic.

5.4 Problem Statement and Research Method

This paper addresses three core issues:

- **Developing a Theoretical Framework to Understand the Affecting Mechanism**

The mixed empirical evidence regarding the impact on tax collection efforts may stem from a lack of a cohesive theoretical model. To address this, the study constructs a Ramsey model tailored for subnational governments. This model aims to elucidate the

mechanisms through which intergovernmental transfers influence tax collection efforts, offering a structured approach to understand these dynamics.

- **Enhancing Tax Collection Effort Estimation via the Kalman Filter**

In an effort to refine the estimation of tax collection efficiency among state governments in the United States, this paper employs the Kalman filter. Recognized for its unbiased estimation capabilities, the Kalman filter represents a significant improvement over traditional proxies like actual tax burden or the ratio of tax revenue to GDP. This methodological choice is expected to provide a more accurate assessment of unobservable tax efforts.

- **Clarifying the Relationship Between Intergovernmental Transfer Restrictions and Tax Collection Effort**

Prior applications of the Kalman filter estimator have primarily concentrated on national economies, neglecting the tax collection efforts of subnational governments. This gap has resulted in a missed opportunity to apply the Kalman filter in exploring how intergovernmental transfers affect tax efforts. This study seeks to fill this void by focusing on the tax collection efforts of American state governments, thereby shedding light on the nuanced relationship between restricted intergovernmental transfers and tax collection efforts. This exploration is critical for understanding the broader implications of fiscal federalism and intergovernmental fiscal relations.

5.4.1 Research Method

This study employs a mixed-methods approach, integrating both theoretical modeling and empirical analysis to explore the impact of intergovernmental transfers on the tax collection efforts of subnational governments.

The theoretical framework is grounded in a nuanced Ramsey model that examines the potential shifts in tax effort induced by these transfers. Empirically, the research innovates by applying a panel data model utilizing the Kalman filter, a method chosen for its adeptness in estimating unobservable variables like tax effort. This combination allows for a robust assessment of the effects of different types of grants on local tax collection practices.

The empirical section of this research leverage a panel dataset across various states within the United States over a specified period. With the Kalman filter algorithm

adjusted tax collection effort as dependent variables, the panel data regression facilitates a more accurate estimation of the effect of intergovernmental transfer on tax collection effort. This methodological choice is substantiated by a detailed literature review that underscores the Kalman filter's superiority in estimating unobservable variables compared to other estimators.

5.5 Model Construction

This section is for the Ramsey problem model construction under which subnational governments are deciding their behavior within given budget constraint to maximize their utility. The section is grouped in two parts. First part is about the basic setup of the Ramsey problem and the second is the process for subnational government to solve the problem.

5.5.1 General Setup of the Ramsey Problem

The budget of subnational government comes from two parts—transfer from national government and tax collection. To address the underemphasized categorical transfer, I assume national government make both general transfer and categorical transfer to subnational government.

Most investigation on intergovernmental transfer identify the amount of general transfer is that general transfer T_{gi} to region i is negatively related to the total output in i , which I represents as F_i (Buettner, 2006b; Egger et al., 2010; Köthenbürger, 2002). The allocation function for general transfer amount is $T_0 - \sigma F_i$, where T_0 is the benchmark amount when the tax base in i is 0 and σ is the "equalization parameter". A greater σ means national government prefer to a equalized development in different regions¹.

In terms of categorical transfer, I distinguish the productive spending P_i with the welfare spending W_i in region i . I assume the categorical transfer is following matching mechanism. The central government can influence the quantity and allocation of specific categorical transfers by adjusting the matching rates $0 < m < 1$ and $0 < n < 1$ for different domains of public expenditure. The matching ration in different sectors and are also decided by national government. The national government can decide the categorical transfer be spent either on productive public goods P or welfare public goods

¹In this paper, the amount of general transfer and categorical transfer is exogenous for subnational government.

W . Therefore the transfer flow direction and matching ratio is exogenous for subnational government. In this logic, the total amount of categorical transfer in i can be written as:

$$m_i P_i + n_i W_i \quad (5.1)$$

Revenue source of the subnational government comes from intergovernmental transfer, including general transfer and categorical transfer, and tax revenue. Total revenue is spent on either productive public goods or welfare-oriented public goods, thus the budget constraint for subnational government is:

$$P_i + W_i = \tau_i F_i + (T_0 - \sigma F_i) + (m_i P_i + n_i W_i) \quad (5.2)$$

Subnational government care about both welfare utility and after tax output, thus the utility function for subnational government can be expressed as:

$$U_i = (1 - \tau_i e_{i,t}) F_i + \lambda_i W_i \quad (5.3)$$

This utility function is inspired by a very general utility function setting in public economics analysis (Cai & Treisman, 2005; Edwards & Keen, 1996; Persson & Tabellini, 2002) adopted. The only modification that I have changed is the utility of expenditure on welfare-type public services to be linear. Such a modification certainly sacrifices some rationality, as Cai and Treisman (2005)'s setup still assumes that the utility function of public services and products is concave. However, in order to obtain an arithmetic representation and explore the relationships between coefficients, such a modification is necessary. τ_i is nominal tax rate and $e_{i,t}$ is the tax collection effort. The actual tax burden is decided by nominal tax ratio, which doesn't fluctuate with time change, and tax collection effort, which can adjust flexibly. The actual tax burden $\tau_i \cdot e_{i,t} < 1$, which means the actual tax burden should be lower than 100%. λ_i is the demand of welfare utility. A greater λ_i means subnational government prefer welfare utility and make light of productive utility, vice versa.

Production output is considered to be determined by the capital amount and governmental spending on productive public goods(Cai & Treisman, 2005). I follow Lv and Zhang (2018)'s assumption that the production function in region i is:

$$F_i = A_i K_i^\alpha P_i^\beta \quad (5.4)$$

K is the capital amount. α and β is the elasticity of K and P . This I assume that

$\alpha + \beta < 1$, since other factors may related to production in addition to capital and productive spending.

5.5.2 Problem Solve Process

I assume the capital can flow freely and overlooked how the capital flow reach final equilibrium, instead, I just assume that the capital has reached the equilibrium and state government want to maintain the utility at certain level thus keep the equilibrium condition.

Under equilibrium condition, the capital profits rate should be a constant rate, thus I have:

$$(1 - \tau_i) \frac{\partial F_i}{K_i} = r \quad (5.5)$$

Thus I can express K as a function of A_i , r and P

$$K_i(P_i, r, A_i) = \left[\frac{1}{r} (1 - \tau_i) A_i \alpha P_i^\beta \right]^{\frac{1}{1-\alpha}} \quad (5.6)$$

With equation 5.3, 5.4 and 5.2, we can get the first order condition on P :

$$P_i = \left[\frac{\beta A_i k^\alpha [(1 - \tau_i e_{i,t}) (1 - n) + \lambda_i (Z_i e_{i,t} - \sigma)]}{\lambda_i (1 - m)} \right]^{\frac{1}{1-\beta}} \quad (5.7)$$

With equation 5.6 expressed as known parameters, 5.7 is also known.

With equation 5.7 and 5.2, we can get the expression on W_i :

$$W_i = \frac{(\tau_i e_{i,t} - \sigma) F_i + T_0 - (1 - m) P_i}{(1 - n)} \quad (5.8)$$

with P_i expressed in equation 5.7, F_i expressed in equation 5.4 and equation 5.6, W_i is also known for us.

Based on equation 5.7 and 5.8, the utility of region i can be expressed as:

$$U_i = \frac{[1 - n - \lambda_i \sigma - (1 - n - \lambda_i) \tau_i e_{i,t}]}{1 - n} A_i K_i^\alpha P_i^\beta - \frac{1 - m}{1 - n} \lambda_i P_i + \frac{\lambda_i T_0}{1 - n} \quad (5.9)$$

The question I want to investigate is the effect of transfer payment on the actual tax collection efficiency. Based on equation 5.9, subnational government want to maintain the utility on certain level by adjusting tax collection effort when national government change some of the parameters such as T_0 , γ , m and n . Therefore I need to express $\frac{de_{i,t}}{dT_0}$, $\frac{de_{i,t}}{d\sigma}$, $\frac{de_{i,t}}{dm}$ and $\frac{de_{i,t}}{dn}$.

With equation 5.9, 5.6 and 5.7, I can calculate the relationship between $e_{i,t}$ and T_0 based on the implicit differentiation rule.

$$\frac{\partial e_i}{\partial T_0} = \frac{\lambda_i(1-\alpha)^{(1-\alpha)\theta}\alpha^{-\alpha\theta}r^{\alpha\theta}(1-e_{i,t}\tau_i)^{1-\alpha\theta}A_i^{-\theta}\beta^{-\beta\theta}(\lambda_i(e_{i,t}\tau_i-\sigma)+(1-n)(1-\tau_ie_{i,t}))^{1-((1-\alpha)\theta)}}{\tau_i[(1-n-\lambda_i)(1-\tau_ie_{i,t})+\alpha\lambda_i(1-\sigma)]} \quad (5.10)$$

where $\theta = \frac{1}{1-\alpha-\beta}$. Also, based on the implicit differentiation rule, I have relationship between $e_{i,t}$ and σ , $e_{i,t}$ and m , $e_{i,t}$ and n , which can be listed as equation 5.11, 5.12, 5.13.

$$\frac{de_{i,t}}{d\sigma_i} = -\frac{\lambda_i}{\frac{\alpha(1-\tau_i)(1-n_i)+\lambda_i(\tau_i-\sigma_i)}{1-\tau_i} + (1-n_i-\lambda_i)} \quad (5.11)$$

$$\frac{de_{i,t}}{dm_i} = \frac{\beta(e_{i,t}\tau_i-1)((1-n)(1-e_{i,t}\tau_i)+\lambda_i(e_{i,t}\tau_i-\sigma))}{(m-1)\tau_i[(1-n-\lambda_i)(1-\tau_ie_{i,t})+\alpha\lambda_i(1-\sigma)]} \quad (5.12)$$

$$\frac{d\tau_i}{n_i} = \frac{(1-n_i)^{-1}[-\beta\theta(1-\tau_i)(1-n_i)-\lambda(\tau_i-\sigma_i)]}{\alpha\theta\frac{(1-\tau_i)(1-n_i)+\lambda_i(\tau_i-\sigma_i)}{1-\tau_i}+\theta(1-\alpha)(1-\lambda_i-n_i)} \quad (5.13)$$

The theoretical conjecture below will mainly focus on discussing the positivity or negativity of each expression.

5.6 Theoretical Conjecture

This sector discuss the relationship between different kinds of intergovernmental transfer and tax collection effort. Based on the expression I get of $\frac{\partial e_{i,t}}{\partial T_0}$, $\frac{\partial e_{i,t}}{\partial \sigma}$, $\frac{\partial e_{i,t}}{\partial m}$ and $\frac{\partial e_{i,t}}{\partial n}$. The discussion is mainly based on the positivity or negativity of equation 5.10, 5.11, 5.12 and 5.13.

5.6.1 The effect of general transfer on tax collection effort

Whether equation 5.10 is positive or negative is decided by:

$$\frac{(1-n)(1-e\tau_i)+\lambda_i(e_{i,t}\tau_i-\sigma)}{(1-n-\lambda_i)(1-e_{i,t}\tau_i)+\alpha\lambda_i(1-\sigma)} \quad (5.14)$$

The positivity or negativity of equation 5.14 is decided by both nominator and denominator. From equation 5.4 and 5.6, $\frac{\partial F_i}{P_i} + \frac{\partial F_i}{K_i} \frac{\partial K_i}{\partial P_i} > 0$, thus I have $(1-\tau_i)(1-n_i)+\lambda_i(\tau_i-\sigma_i) > 0$, which is the nominator of equation 5.14. Therefore the positive or

negative of equation 5.14 is decided by denominator, thus I get some implications about the effect of bench general transfer amount T_0 :

- When $n_i + \lambda_i < 1 + \frac{\alpha\lambda_i(1-\sigma_i)}{1-\tau_i}$

In this circumstance, equation 5.14 >0 , thus $\frac{\partial e_{i,t}}{\partial T_0} > 0$. In another word, when both national and subnational governments don't care about the welfare oriented public goods such that $n_i + \lambda_i$ cannot reach a specific threshold, the greater T_0 leads to greater tax collection effort, and that threshold is $1 + \frac{\alpha\lambda_i(1-\sigma_i)}{1-\tau_i}$.

- When $n_i + \lambda_i > 1 + \frac{\alpha\lambda_i(1-\sigma_i)}{1-\tau_i}$

In this condition, equation 5.14 <0 , thus $\frac{\partial e_{i,t}}{\partial T_0} < 0$. When both national and subnational governments care about the welfare oriented public goods such that $n_i + \lambda_i$ can reach a specific threshold, the greater T_0 leads to lower tax collection effort.

One possible explanation is that an increase in taxation may simultaneously increase and decrease the utility of local governments. On one hand, raising taxes can dampen post-tax output. On the other hand, the additional tax revenue can augment investment in productive public goods, thereby enhancing output. When both central and local governments are less concerned about welfare-related public goods, general transfers can facilitate local governments in achieving their revenue targets more easily. However, in such scenarios, the stimulative effect of increased productive expenditure due to higher tax burdens outweighs the inhibitory effect, prompting local governments to increase tax efforts until the marginal utility of such efforts reaches zero. Illustrated by the Laffer curve in figure B.22, in the absence of transfer payments, local governments adjust tax burdens to ensure that the marginal effect of actual taxation equals zero, where the marginal stimulus equals the marginal inhibition. Conversely, in the presence of general transfers, the Laffer curve shifts to the right. In situations where local governments prioritize productive public goods, increasing tax efforts to allocate more resources to productive public goods becomes a more rational approach.

However, if both central and local governments prioritize welfare-related production expenditures beyond a certain threshold, the situation changes. In this case, increasing general transfers will encourage local governments to allocate more resources to the provision of welfare-related public goods. Consequently, increasing taxes will only exacerbate the crowding-out effect of high tax burdens on total production F . Therefore, increasing general transfers will instead prompt local governments to seek ways to alleviate tax burdens.

5.6.2 The effect of categorical grants in productive area on tax collection effort

Since $0 < m < 1$, whether equation 5.12 is positive or not is decided by denominator. Similarly, $1 + \frac{\alpha\lambda_i(1-\sigma_i)}{1-\tau_i}$ also acts as a threshold. From the calculation, we have:

- When $n_i + \lambda_i < 1 + \frac{\alpha\lambda_i(1-\sigma_i)}{1-\tau_i}$, $\frac{d\tau_i}{dm_i} > 0$
- When $n_i + \lambda_i > 1 + \frac{\alpha\lambda_i(1-\sigma_i)}{1-\tau_i}$, $\frac{d\tau_i}{dm_i} < 0$

When both national and subnational governments care less about welfare oriented spending, more categorical transfer on productive public goods would stimulate a higher tax collection effort, vice versa.

In the realm of categorical transfers, the effect of increasing the subsidy ratio for productive transfers by the central government on local tax efforts is entirely consistent with the increase in general transfers. This is not surprising, as even without restrictions on the usage domain of general transfers when both local and central governments prioritize productive public goods over welfare-related ones, local governments will still allocate more revenue to productive public goods. This parallels the effect of the central government stipulating a high matching ratio m to encourage local governments to invest more in productive areas.

When both national and subnational governments care about the welfare oriented public goods such that $n + \lambda_i$ surpass the threshold, the greater matching ratio on productive public goods would not stimulate subnational government to invest more on productive spending. On the contrary, the relief on the productive investment would lead to lower revenue gap thus lower the tax collection effort.

5.6.3 The effect of categorical grants in welfare area on tax collection effort

The calculation and the expression of $\frac{\partial e_{i,t}}{\partial n}$ is complicated. I got the expression through Mathematica, the result is shown in figure B.21.

This expression is very complicated and hard to distinguish whether it's positive or negative, which means the effect of matching ratio of welfare-oriented public spending is ambiguous. We hypothesize that when the national government increases categorical transfers for welfare, it simultaneously incentivizes local governments to further increase the utility derived from welfare expenditures, thereby encouraging higher taxation.

However, the role of taxation in economic growth is uncertain. Subnational government may want to decrease the tax collection revenue to boost the economic growth, since the investment in welfare is guaranteed by the subsidy. Therefore, the impact of increased welfare transfers on taxation incentives is uncertain.

For the following of this paper, I'll design an empirical investigation to statistically test my theoretical conjecture.

5.7 Regression Model Design and Hypothesis

This section is to give some general explain of the regression setting, such as the included factors and the regression model. In addition, I give my hypothesis about some of the factors based on the theoretical conjecture I get from previous Ramsey model.

The regression is to distinguish the effect of different kinds of intergovernmental transfer on the tax collection effort. Therefore, the dependent variable of this regression is the tax collection effort, which has been corrected using the Kalman filter algorithm. The specific algorithmic process will be detailed in subsequent sections. The independent variables consist of the ratio of general-purpose transfer payments to specific-purpose transfer payments. Our interest lies in exploring the impact of the growth or reduction of these ratio on tax collection efforts.

Based on our discussion of the theoretical model, there exists a "threshold effect" in the impact of general-purpose and specific-purpose transfer payments on tax collection efforts. The degree of emphasis placed by the federal and state governments on welfare-related public expenditures, represented as $n_i + \lambda_i$ plays a pivotal role in serving as such a threshold. Based on this theoretical inference, a moderating effect model would be particularly helpful in addressing our inquiry. Specifically, it would investigate how the effects of general-purpose and specific-purpose transfer payments on tax collection efforts are moderated by the degree of emphasis placed by the federal and state governments on welfare-related public expenditures.

5.8 Variables and Sample

This subsection is constructed to explain the meaning of the variables and how it's measured. The most important part is to explain the construction of moderating variables and how the dependent variable—tax collection effort is captures.

5.8.1 Construction of moderating variables

The moderating effect in this study exists between two pairs of variables: the variable *Ratio_gen*, reflecting general-purpose transfer payments, and the variable *w_preference* representing the degree of emphasis placed by the federal and local governments on welfare expenditures, respectively. Additionally, the moderating effect exists between the variable "transfer payments with purpose constraints" *Ratio_cons* and *w_preference*. Therefore, my regression model comprises two regression equations.

$$TE_{i,t} = a + \beta_1 Ratio_{gen_{i,t}} + \beta_2 w_{preference_{i,t}} + \beta_3 (Ratio_{gen_{i,t}} \cdot w_{preference_{i,t}}) + \alpha_i CV_{i,t} \quad (5.15)$$

$$TE_{i,t} = a + \beta_4 Ratio_{cons_{i,t}} + \beta_2 w_{preference_{i,t}} + \beta_5 (Ratio_{cons_{i,t}} \cdot w_{preference_{i,t}}) + \alpha_i CV_{i,t} \quad (5.16)$$

where CV means a set of control variables including ratio of different industrial sectors in the whole economy, such as agriculture, manufacturing, finance and insurance, trade and real estate and some factors reflecting economic condition such as gdp per capita, per capita expenditure, median household income and unemployment rate.

The construction of interacting variables is in regression 5.15 and 5.16 needs the representing of the general grants ratio *Ratio_gen_{i,t}*, matching ratio on productive spending *Ratio_cons_{i,t}*, and both level of governments' preference on welfare spending *w_preference_{i,t}*.

From *State Expenditure Annual Report* published by different state governments, I can classify federal and state governments' spending purpose into spending on productive and welfare oriented area. In addition, I can tell the source of the revenue by distinguishing if the grants is offered by federal or state governments. According to former investigation related to the classification of welfare spending and productive spending (Anping & Zhi, 2012; Lindbeck & Weibull, 1988; Schneider & Jacoby, 2005; Stichnoth & Van der Straeten, 2013; Wlezien & Soroka, 2021), I group the spending on education, assistance on needy, cash assistance, medicaid, corrections as welfare spending and spending on transportation, housing and environment as productive expenditure². As also shown in table A.16, I can calculate whether the grants come from federal or states. Therefore I have the ratio

²The abbreviation for welfare expenditure is marked as "W" in table A.16 and productive expenditure is marked as "P".

of welfare expenditure of state and national government to represent the preference on welfare spending $w_preferernce$.

White house Office of Management and Budget supplied publish federal's total outlay every year, in which we can find the proxy of general grants amounts under "Federal funds" account and grants with constraint amounts under "Trust funds". The general grants amounts is clearly defined, while the ratio of productive grants and welfare grants need to be distinguished manually.

Every state in America is included in my sample and the time span last from 2000 to 2019, unless some specific data is missed.

The explain of the moderating effects coefficients are different compared to the normal regression. For example, in equation 5.15, β_1 is not the effect of general transfer on tax collection effort. To investigate the effect of general transfer ratio on dependent variable, I need to calculate $\frac{\partial TE_{i,t}}{\partial Ratio_gen_{i,t}}$, thus I have:

$$\frac{\partial TE_{i,t}}{\partial Ratio_gen_{i,t}} = \beta_1 + \beta_3 \cdot w_preferernce_{i,t}$$

Therefore, β_1 is not the effect of general transfer on the tax collection effect, rather, it means the effect of general transfer when $w_preferernce_{i,t} = 0$. As $w_preferernce_{i,t}$ gets greater, we can tell the effect of general transfer on tax effort by analyzing $\beta_1 + \beta_3$. This feature fits our previous theoretical conjecture perfectly since the preference on welfare public spending plays an threshold effect. We can better investigate this threshold effect through the moderating effect regression model. Based on the explain of this moderating effect regression and previous theoretical conjecture, I generated the first hypothesis.

- Hypothesis 1: Tax effort gets higher as general transfer ratio gets higher when both federal and state governments make light of welfare-oriented public spending.**

This hypotheses comes from the theoretical conjecture of the general transfer ratio. In the regression, my expectation is that β_1 is a significant positive value while β_3 is a significant negative value. In that way, the effect of general transfer ratio on tax collection effort is negative when $w_preference$ doesn't exceed the threshold. Once the $w_preference$ pass the specific threshold value, the increase of general transfer discourage the tax collection effort.

Similarly, I can have the hypotheses about the effect of productive categorical transfer increase on tax collection effort.

- **Hypothesis 2: Tax effort gets higher as productive categorical transfer ratio gets higher when both federal and state governments make light of welfare-oriented public spending.**

The effect of productive categorical transfer follows same logic with the general transfers. Whether the increase of productive categorical transfer stimulates or suppress tax collection effort depends on if federal and state governments' preference on welfare spending surpass a specific threshold. Therefore I'm expecting a significant positive β_4 and negative β_5 . When $w_{preference}$ gets greater, the effect of productive categorical transfer became negative.

5.8.2 Measure of tax collection effort

In terms of the dependent variable, tax collection effort, two methods are commonly employed: the average tax ratio method and the potential tax revenue method(1978; 1983; 1981). The former entails substituting the unobservable variable of tax collection with a proximate and measurable variable. Conversely, the latter method involves comparing the actual tax burden to the predicted tax burden using regression analysis, which is also called as "tax handle" method. According to Bahl (1971), an index of 1 means the tax effort is at the "expected" level, given the structural factors of that country. In other words, the country is using its taxable capacity at a level consistent with the average of the other countries in the sample (Mertens, 2003).

However, Kim (2007) has demonstrated that while the second method, compared to the first, provides relatively more reliable estimates of tax collection effort, both methods are inherently biased. In the same article, Kim (2007) proposed a solution to this issue by using the Kalman filter to correct tax collection effort and proved its efficiency and unbiasedness in estimating tax collection effort. Therefore, this article also employs this approach to estimate tax collection effort for each state. Specifically, following Kim's methodology, the Kalman filter estimation of tax collection effort involves the following processes.

The state-space model is represented as:

$$Y_t = \gamma X_t + \alpha A_t + \varepsilon_t \quad (5.17)$$

$$X_{t+1} = \beta X_t + \omega_{t+1} \quad (5.18)$$

where Y_t is the tax revenue at time t , X_t is tax effort and A_t is a vector of other factors affecting tax revenue except for tax effort. The error terms ε_t and ω_t are both serially uncorrelated with a mean of zero and a covariance matrix h_t and q_t respectively. Therefore we have:

$$\begin{pmatrix} \varepsilon_t \\ \omega_t \end{pmatrix} \sim N \left(\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} h_t & 0 \\ 0 & q_t \end{pmatrix} \right) \quad (5.19)$$

X_t has a known mean a_0 and a variance b_0 . Therefore, if the variances of the error terms and the initial values of revenue effort and its variance are known, tax revenue effort can be derived with the following Kalman filter equations (Kim, 2007):

$$\hat{X}_{t+1,t} = \tau \hat{X}_{t,t} \quad (5.20)$$

$$P_{t+1,t} = \tau^2 P_{t,t} + q^2 \quad (5.21)$$

$$B_{t+1,t} = \alpha^2 P_{t+1,t} + h^2 \quad (5.22)$$

$$\hat{\epsilon}_{t+1,t} = Y_{t+1} - \alpha \hat{X}_{t+1,t} - \beta A_{t+1} \quad (5.23)$$

$$K_{t+1} = P_{t+1,t} \alpha B_{t+1,t}^{-1} \quad (5.24)$$

$$\hat{X}_{t+1,t+1} = \hat{X}_{t+1,t} + K_{t+1} \hat{\epsilon}_{t+1,t} \quad (5.25)$$

$$P_{t+1,t+1} = (1 - K_{t+1} \alpha) P_{t+1,t} \quad (5.26)$$

From equation 5.20 to equation 5.26, I can get a kalman filter processed series data $\{X_{t,t}\}$ of each state i. Now I need to specify the state-space model formed up by measurement equation, which is equation 5.17 and transition equation, which is equation 5.18.

Equation 5.17 is the commonly used "tax handle" regression. I focus on the tax collection effort of states governments, thus the commonly used tax handle should includes the factors that reflect the economic structure. Based on the North American Industry Classification System (NAICS), I categorized all industries into 11 major groups:

Agriculture; Mining; Manufacturing; Wholesale trade and retail trade; Transportation and warehousing; Information; Finance and insurance; Real estate, rental, and leasing; Health care and social assistance; Professional, scientific, educational, and technical services. I'll calculate the ratio of each industries compared to state GDP and make it as tax handles. Besides, the commonly used control variables to predict the tax revenue includes GDP per capita, median household income and unemployment rate. Therefore the variables included in A_t can be listed as table A.17.

Given the diverse economic structures across different regions in the United States, industries serving as tax bases vary. Recognizing the variation in tax bases created by different economic structures in various regions, I segmented the data by region to conduct fixed-effects regressions based on the U.S. Department of Commerce Bureau of Economic Analysis' classification of regions , aiming to maximize the adjusted R-squared and enhance predictive accuracy. Those 8 segments are: Far West, Great Lakes, Mideast, New England, Plains, Rocky Mountain, Southeast, Southwest.

The DF test result, shown in table A.18 for each variable within each region shows that some time series data are not stationary, which contradicts with the assumption of equation 5.19. Therefore before the tax handle regression, I conduct the 1 st order difference for the variables that do not pass the DF test and make sure all variables of states i are stationary before conducting the tax handle regression ³.

Given that the primary objective of this regression equation is prediction, multi-collinearity is not a significant concern. The tax handle regression results can be listed as table A.19. In this table, we can tell clearly that the significant industries, which is tax handles that determinant the tax revenue of states, are different. For example, the manufacturing industry is important for states in Plains area, while it's not significant for other areas such as states in far west, great lakes, mideast and new england. This also reflects the significance to predict the revenue and conduct the tax handle regression by region.

The tax handle regression in different regions are listed in Table A.19. After removing the insignificant factors, I get the predicted tax revenue ratio based on the significant tax handles. For example, for states in far west area, the predict formula is listed as:

$$Tax_revenue_predict = tandw*1.674 + fandi*1.133 - 3.223*hs + trade*0.818 + gdppercapita*0.029 \quad (5.27)$$

³Table A.18 only shows part of the DF test results. For full results, please visit the appendix part

After the tax handle regression, I get the predicted tax revenue ratio for different state. Then I can get the tax collection effort by calculating the predicted value with actual value $\frac{\text{Tax_revenue_predict}}{\text{Tax_revenue_actual}}$. Part of the descriptive results is shown in table A.21. Therefore, I have the measurement equation ready among the space-state equations since I have X_t in equation 5.17 known parameters. In addition, the B-W heteroskedasticity test confirms that regression of equation 5.17 follows the constant residuals, shown in table A.20

For transition equations, I assume the transition process follows an AR(1) process and the coefficient of the autocorrelation is 1 since table A.21 shows most of the tax effort index lies in [0.7, 1.2] and the standard error is small⁴.

So far I got the space-state equation prepared and the initial parameters for kalman filter process is known including γ , α , α , $X_{0,0}$, $P_{0,0}$. Therefore, through equation 5.20 to equation 5.26, I have a new kalman algorithm adjusted series of tax collection effort $\{X_{t,t}\}$.

After the estimation of tax collection effort, I can run regression 5.15 and regression 5.16. The results can be listed as Table A.22

5.9 Regression Results and Analysis

The regression result is shown in table A.22. Both OLS regression and fixed regression, with state and time fixed, are adopted with different variables included. To control the heteroskedasticity problem, I included robust standard error in both regressions. The adjusted R-square and the significance of all models are acceptable, but I adopt the coefficients of fixed effect model as reference, in which state and time variable fixed.

The first hypotheses about the general transfer ratio is supported. From model 4, the coefficient of *generalratio* is 17.64 and it's significant on 5% confident level. The coefficient of the interaction variable *int_gen_pref* is -23.64 and it's also statistically significant. This coefficients combination strongly supported our hypotheses about the effect of general grants on tax collection effort: when federal and state government care less about the welfare-oriented public spending, more general transfer lead to higher tax collection effort. For example, when both levels of governments do not care about welfare at all, which means $n + \lambda = 0$, $\frac{\partial TE}{\partial \text{generalratio}} = \beta_1 = 17.64$. Once federal or state government attach importance to the welfare product, thus federal increase the matching ratio of welfare spending n and state government get more utility for

⁴This assumption is not necessarily to be too precise.

welfare spending, which makes $n + \lambda_i$ pass the threshold, the marginal effect of general transfer ratio on tax collection effort became negative. For example, when $n + \lambda = 1$, $\frac{\partial TE}{\partial generalratio} = \beta_1 + \beta_3 = -6$.

The second hypothesis is not supported unfortunately. On the contrary, the coefficient of constraint ratio β_4 in model 3 equals to -14.38 and the coefficient of the interaction term $int_{cons}ref$ equals to 19.25. This means that, though we do observe an threshold effect, the effect is not act similarly with general transfer, just the opposite, the marginal effect on the matching ratio on productive spending m is positive when both levels of governments neglect the welfare spending, and such marginal effect turns to negative when $n + \lambda$ exceeds the threshold.

The moderating effect of the two regression models are represented in figure B.23 and B.24.

The chart titled "Interaction effect between general transfer ratio and W-preference" depicts how varying levels of W-preference (preference for welfare-oriented public spending) influence the tax collection effort across different general grants ratios. It uses a box plot representation to contrast two scenarios: one with high W-preference and another with low W-preference, across two categories of general grants ratio (lower and higher).

From the dashed line (Low W-preference), we can tell when there is a low preference for welfare-oriented public spending, the tax collection effort increase slightly as the general grants ratio increases. Conversely, with a high preference for welfare spending, the tax collection effort increases rapidly with higher general grants ratios⁵. The difference between the two rectangle is the moderating effect of the $w_preference$. It obvious that with greater importance attached to welfare oriented spending, the stimulative effect of the general categorical on tax collection effort is diminishing significantly. One natural deduction is, when the importance attached to welfare spending surpass the threshold, the effect of the general transfer ratio would became negative.

One explanation for the unexpected effect of productive categorical grants is, the effect of productive oriented grants and welfare-oriented grants could not be perfectly separated in the regression, thus the variable *constraintratio* may not solely express productive categorical transfer. This may comes from data mixture and effect interaction. For one, we do not have an official definition about what kinds of categories of spending is considered as "productive" or "welfare". Therefore, related investigation needs to clarify the categories manually. During this process, the boundary of productive categorical

⁵The interaction effect chart express the effect in line not curve, so this is not a precise description about the effect of the general transfer ratio. The focus is on the effect of moderating factor, which is $w_preference$ here.

transfer and welfare categorical transfer may become blurred, leading to regression results deviating from expectations. For example, Cai and Treisman (2005) claims that "Infrastructure" should be interpreted broadly, including in their research that physical infrastructure (transportation, telecommunications, etc.), education, public health, and a system of well-enforced property rights and legal protections.

On the contrary, due to the relatively clear definition of general transfer payments and accurate numerical values, the econometric results align perfectly with theoretical deductions.

In addition to data mixture, another mechanism that contributes to the confounding effects of productive and welfare-specific expenditures is the diverse roles that various public investments play in economic life, which I called as interaction. For instance, social security expenditures like TANF, often perceived as purely welfare-related, also enhance the purchasing power of impoverished individuals, thereby stimulating economic growth. Similarly, public expenditures directed towards correctional facilities contribute to providing a stable and secure social environment, aiding in the reintegration of ex-convicts into society by facilitating skill development. Thus, even welfare-related expenditures may not necessarily be entirely unrelated to the overall societal output, as posited in theoretical models.

5.10 Review and Summary

This article constructs a theoretical Ramsey model based on the classification of transfer payments and the government utility function. Through solving the Ramsey model, theoretical inferences regarding the effects of general transfer and categorical transfer payments on local government tax efforts are derived. This theoretical model attempts to address two gaps in current research. Firstly, previous studies have mostly focused on discussing the impact of general transfer payments on tax efforts, with relatively fewer discussions on the role of categorical transfer, which is relatively strictly constrained. However, this article distinguishes between types of transfer payments and considers the allocation area of categorical transfer payments, thereby enabling the examination of the effects of other types of transfer payments beyond general ones. Secondly, prior research has predominantly relied on empirical tests, resulting in inconsistent conclusions on the same topic. For instance, regarding the impact of general transfer payments on tax efforts, opinions have varied between fostering and inhibiting effects. This article, through the established theoretical model, goes beyond empirical test results and discusses why the

empirical evidence support divergent conclusions.

In addition to the theoretical model, this article also gathers panel data from all states in the United States from 2000 to 2019 to validate the theoretical inferences. This empirical test also innovates existing literature in two aspects. Firstly, by employing the Kalman filter, this article overcomes the difficulty of observing tax efforts and the biased proxy as substitute. Secondly, through moderating effect regression analysis, the article partially confirms the theoretical inferences.

Of course, the article also has certain limitations. Firstly, the theoretical inference regarding the impact of productive categorical transfer on tax efforts has not been empirically supported. I provided two potential reasons of the divergence, but further discussion is needed to determine whether the theoretical prediction is supported. Secondly, the article fails to provide a clear theoretical inference regarding the impact of welfare-specific transfer payments on tax efforts.

Future research in this area could focus on three main directions. Firstly, efforts could be made to improve the quality of data, particularly in accurately distinguishing between productive specific-purpose transfer payments and welfare-specific specific-purpose transfer payments during data classification. Secondly, regarding empirical testing methods, future research could explore how to accurately identify the effects of specific-purpose transfer payments in empirical tests.

Chapter 6 |

Summary, Thoughts and Rethink

Within the vast landscape of fiscal systems, understanding the dynamics between resource collection and reallocation is crucial, as it directly ties to the provision of public goods. This discourse inevitably introduces a pivotal concept: the "tradeoff," which underlies fiscal system designs, embodying the necessity to balance divergent goals and constraints. Fiscal federalism, a structure widely embraced across the globe, brings the principles of centralization and decentralization into sharp relief, particularly within the realm of intergovernmental transfers. These mechanisms showcase a constant negotiation between the need for centralized coordination and oversight to achieve national objectives and the decentralized approach that values regional autonomy and tailored responses to local needs. This chapter delves deeper into how intergovernmental transfers encapsulate these tradeoffs, reflecting broader themes of fiscal policy and governance. It seeks to distill and expand upon insights scattered throughout the investigation into a cohesive summary, thus framing the thesis within the ongoing dialogue between centralization and decentralization in public administration. In this chapter, I want to extract some thoughts that spread all over the intergovernmental transfer investigation, which also accounts to a summary of this thesis.

6.1 Overall Interests and Partial Interests

One of the intrinsic contradictions within intergovernmental transfer design, is the balancing act between overall interests and partial interests. This dichotomy is not merely a conceptual framework but a practical reality that affects decision-making at various levels of government—national and subnational. The inherent tradeoff between these interests is a reflection of the complex interplay between the desire for collective welfare and the pursuit of localized benefits.

Intergovernmental transfer policy, by design, incorporates at least two layers of government: the national government and multiple layers of subnational governments, each with its domain of fiscal responsibilities and autonomy. The national government is tasked with considering the benefits for all regions, aiming to optimize the welfare of the country as a whole. In contrast, subnational governments, such as states or provinces, focus on their regions' specific needs and priorities.

This divergence in focus leads to a fundamental tradeoff in fiscal policies and resource allocation. National governments, aiming for broader economic stability and equitable development, might prioritize policies that do not always align with the immediate interests or preferences of subnational governments. For instance, a national government might implement general transfer payments to ensure that all regions have the necessary resources to provide basic public services. However, these allocations may not always reflect the unique needs or priorities of individual regions, leading to disparities in satisfaction and perceptions of fairness.

The dynamic complete game model discussed in Chapter 2 underscores this tradeoff, illustrating how national governments utilize general transfer payments and joint provisions to reconcile these conflicting interests. The model's equilibrium outcomes suggest that while general transfers and joint provisions are essential tools for addressing overall interests, they might not universally be welcomed by all subnational regions. This scenario encapsulates the essence of the tradeoff between overall and partial interests: the pursuit of collective welfare might necessitate compromises that do not fully satisfy the localized ambitions of individual regions.

Moreover, this tradeoff extends beyond fiscal transfers to encompass the broader considerations of externality management and public goods provision. The principle that "the whole is more than the sum of its parts" finds practical expression in how externalities are addressed within the fiscal federalism framework(Branstetter et al., 2001; Lewis & Bajari, 2011; Shapiro, 1988). National governments are often in a position to internalize externalities that transcend regional boundaries, such as environmental pollution, interstate infrastructure projects, and national education standards. These efforts, aimed at optimizing the overall welfare, might impose constraints or redirect resources in ways that do not align with the immediate preferences of subnational governments.

In summary, the tradeoff between overall interests and partial interests within fiscal federalism is a reflection of the inherent tensions between collective welfare and regional autonomy. This tradeoff is not merely a theoretical construct but a practical reality

that influences policy formulation, resource allocation, and the pursuit of equity and efficiency in public goods provision. As this dissertation has illustrated through models and empirical analysis, navigating this tradeoff requires a nuanced understanding of the fiscal federalism framework and a commitment to balancing diverse interests in the pursuit of shared prosperity.

6.2 Efficiency and Equity

The balancing act between efficiency and equity represents one of the most profound dilemmas in the realm of intergovernmental transfer design. This tradeoff is not only a reflection of differing policy objectives but also a manifestation of the underlying values that guide fiscal policy decisions. Efficiency, in this context, refers to the optimal allocation of resources to maximize the economic output, whereas equity is concerned with the fair distribution of resources among different regions or population groups.

Intergovernmental transfers, as a critical component of fiscal federalism, are designed to address disparities across jurisdictions by reallocating financial resources from wealthier to less wealthy areas. However, the pursuit of equity through these transfers often encounters the challenge of maintaining economic efficiency. The inherent tension arises because policies aimed at redistributing resources to achieve a more equitable outcome may inadvertently affect the incentives for local governments and individuals, potentially leading to inefficiencies in resource allocation and utilization.

One aspect of this tradeoff is visible in the design of transfer mechanisms themselves. General transfer payments, aimed at supporting a broad range of expenditures without specific conditions, may promote equity by providing underfunded regions with necessary resources. However, without targeted conditions, these transfers may not always be used in the most efficient manner, as recipient governments have broad discretion over their use. This discretion can lead to inefficiencies if the funds are not allocated to areas of greatest need or potential economic impact.

Conversely, categorical or conditional transfers, which specify the purposes for which funds must be used, aim to enhance efficiency by directing resources to predetermined priorities such as infrastructure development or education. While potentially more efficient, these targeted transfers may not always address the most pressing needs of a region, thereby raising questions about equity. For example, a categorical grant for highway construction may benefit regions with significant transportation needs but do little for areas where healthcare or education requires more urgent attention.

The empirical evidence and theoretical models discussed throughout the dissertation illustrate these tradeoffs in practice. For instance, the dynamic complete game model presented in Chapter 2 highlights how national and subnational governments negotiate the allocation of resources, with each level of government weighing the benefits of efficiency and equity differently. Furthermore, the empirical analysis of transfer payments in the United States from 2000 to 2019 provides insight into how these tradeoffs manifest in real-world fiscal policy decisions.

Ultimately, the tradeoff between efficiency and equity in intergovernmental transfers is a reflection of the broader challenge of balancing competing objectives within fiscal federalism. While efficiency is crucial for maximizing the impact of public expenditures, equity is essential for ensuring that all citizens, regardless of where they live, have access to public services and opportunities for economic advancement. Navigating this tradeoff requires careful policy design, transparent decision-making processes, and ongoing evaluation to adjust strategies in response to changing needs and priorities.

6.3 Long Term Interest and Short Term Interest

The tension between short-term gains and long-term sustainability represents a crucial tradeoff in the realm of fiscal federalism, particularly in the design and implementation of intergovernmental transfers. This tradeoff is at the heart of policy decisions, where immediate benefits are often weighed against potential future costs, influencing the strategic allocation of resources and the formulation of fiscal policies.

Intergovernmental transfers, as mechanisms for redistributing resources among different government layers, embody this tradeoff through their impact on fiscal behaviors, incentives for economic development, and the overall stability of public finances. The choice between prioritizing short-term financial relief or investing in long-term developmental objectives poses significant implications for economic equity and efficiency.

One manifestation of this tradeoff is the strategic use of categorical transfers. Categorical transfers are often designed to address specific policy objectives, such as infrastructure development or education funding. While these transfers can stimulate immediate spending in targeted areas, their restrictive nature may limit the recipient government's ability to allocate resources toward long-term strategic goals. This scenario underscores the tradeoff between achieving immediate policy outcomes and maintaining fiscal flexibility to address future challenges.

Furthermore, the issuance of bonds by national governments to support categorical

transfers introduces another layer to the short-term versus long-term debate. While bonds can provide immediate funding for critical projects, they also impose future debt obligations, transferring the financial burden to future generations. This dynamic reflects a critical tradeoff: the decision to leverage future financial stability for immediate developmental gains.

The impact of this tradeoff extends beyond fiscal policy design to influence the broader economic landscape. Short-term fiscal interventions, while effective in addressing immediate challenges, may not always align with long-term sustainability goals. For example, short-term economic stimuli, though beneficial in revitalizing an ailing economy, may exacerbate long-term fiscal imbalances if not carefully managed. This interplay between immediate benefits and future costs requires a delicate balancing act, ensuring that short-term decisions do not undermine long-term fiscal health and economic stability.

In sum, the tradeoff between short-term interests and long-term sustainability is a defining feature of fiscal federalism, with profound implications for policy formulation, resource allocation, and intergovernmental relations. As highlighted throughout this dissertation, understanding and navigating this tradeoff is essential for achieving balanced and sustainable fiscal outcomes. Policymakers must therefore carefully consider the long-term implications of their decisions, striving to balance immediate needs with future aspirations in the pursuit of fiscal stability and economic prosperity.

Appendix A |

Tables

A.1 Chapter 1

Table A.1: Effective Tax Revenue in America

State	State and Local Taxes (\$ billions)	Personal Income (\$ billions)	Effective Tax Rate
New York	177.8	1,281.10	13.90%
District of Columbia	7.5	55.5	13.40%
North Dakota	5	39.5	12.70%
Hawaii	9.5	75.4	12.60%
Vermont	3.8	32.6	11.70%
United States Total	1,652.80	16,820.30	9.80%
Alabama	16.4	198.9	8.30%
Oklahoma	13.9	174.4	8.00%

Source: U.S. Census Bureau Dataset

Table A.2: Percentage Composition of Tax Revenue by Government Level

Type	Federal	State	Local
Individual income	51.80%	37.20%	4.70%
Corporate income	6.90%	4.70%	1.10%
Other taxes	41.20%	58.10%	94.20%

Table A.3: Divide Grants by level of Restriction Attached

Level of Restriction		
Low Restriction	Medium Restriction	High Restriction
Formula Categorical Grant	Block Grant	Project Categorical Grant
Open-ended Reimbursement		
General Revenue Sharing		

Table A.4: Divide Grants by Form of Administrative Procedure

Form of Administrative Procedure		
Submitting Request	By Formula	Reimbursement
Competitive Grants	Formula grants Formula-project grants	Project Categorical Grant

Table A.5: Questions in Fiscal Federalism Analysis in following chapters

Layers of Government		
	National	Subnational
Spending	1.How public goods provision method is decided?	
	2.How IGT distribution decision is made in national government?	3.What's the spending reaction of sub-national government on IGT?
Revenue	4.What is the revenue collection reaction of subnational government on IGT?	

A.2 Chapter 2

Table A.6: Divide Grants by Level of Restriction Attached

Level of Restriction		
Low Restriction	Medium Restriction	High Restriction
Formula Categorical Grant	Block Grant	Project Categorical Grant
Open-ended Reimbursement		
General Revenue Sharing		

A.3 Chapter 3

Table A.7: States Sample and Grouping

States	Group	Code
Wyoming		
Idaho		
Kansas	Red States	1
Nebraska		
North Dakota		
Maryland		
Massachusetts		
Rhode Island	Blue States	2
New York State		
Washington		
Pennsylvania		
Nevada		
Wisconsin	Swing States	3
Ohio		

Table A.8: Data Source and Operation

Variables		Source	Time Period
Dependent Variable	lg(igt)	State CAFR	
Independent Variables	c p	Ballotpedia	
	gdp	FRED	2000-2019 annually collected
	lgp		
Control Variables	wapw mhi	Census of bureau	
	ur		
	prm	Bureau of transportation statistics	

Table A.9: Social characteristics for Sample States

Variables	Definition	Operation	Source	Time Period
gdp	Real GDP	Log transformation	FRED annually collected	2000-2019
lgp	Population	Log transformation	Census of bu- reau annually collected	2000-2019
wapw	Working age population weight	No operation	Census of bu- reau annually collected	2000-2019
mhi	State median household income	Log transformation	Census of bu- reau annually collected	2000-2019
ur	unemployment rate	No operation	FRED annually collected	2000-2019
prm	public road mileage	Log transformation	Bureau of transporta- tion statistics annually collected	2000-2019

Table A.10: Variables and Operation

Variables		Definition	Operation
Dependent Variable	lg(igt)	IGT from federal to state i	Log
Independent Variables	c	Combinations of levels, branches and parties.	No operation
	p	Dummies to identify i is democratic, republican or swing.	
	log(gdp)	Real GDP	
	log(pl)	Population	
Control Variables	wapw	Working age population weight	Log
	mhi	State median household income	
	ur	unemployment rate	No operation
	prm	public road mileage	Log

Table A.11: Branches and Levels Combination

		Branches	
		administrative	house
Levels	federal	u_1	u_2
	state level	s_1	s_2

Table A.12: Regression Result—part 1

	M-1 OLS	M-2 year,state-fixed	M-3 state-fixed
c2	-0.00169 (-0.64)	-0.00246* (-2.04)	-0.00169 (-0.31)
c3	-0.00873*** (-3.81)	-0.00751*** (-5.31)	-0.00873 (-1.19)
c4	-0.00484 (-1.22)	-0.00746 (-1.78)	-0.00484 (-1.05)
c5	0.00026 -0.07	-0.0163*** -11.89	0.00026 -0.13
c6	0.00216 -0.58	0.0119** -3.84	0.00216 -0.17
c7	-0.0107** (-2.88)	0.000572 -0.62	-0.0107 (-1.25)
c8	-0.00946* (-2.50)	0.00296 -1.44	-0.00946 (-2.17)
c9	-0.00676*** (-3.46)	0.00384 -1.49	-0.00676 (-3.71)
c10	-0.00588 (-1.55)	-0.000158 (-0.03)	-0.00588 (-1.03)
c11	0.000423 -0.19	0.00893** -3.64	0.000423 -0.18

Table A.13: Regression Result—part 2

	M-1 OLS	M-2 year,state-fixed	M-3 state-fixed
c12	-0.00898** (-2.68)	0 (.)	-0.00898 (-1.97)
c13	-0.00083 (-0.24)	0.00919*** -3.98	-0.00083 (-0.39)
c14	-0.00223 (-0.43)	-0.000932 (-0.14)	-0.00223 (-0.19)
c15	-0.0136* (-2.10)	-0.00713** (-3.31)	-0.0136 (-3.33)
c16	-0.006 (-1.65)	0 (.)	-0.006 (-1.13)
Democratic	-0.00585 (-1.49)	-0.0125** (-3.24)	0 (.)
Swing	-0.0175*** (-6.27)	-0.0224*** (-9.75)	0 (.)
Log(population)	-0.0569*** (-5.35)	-0.0548*** (-4.39)	-0.0569* (-5.22)
working age population weight	0.0848 -1.18	0.318** -3.4	0.0848 -0.75
Log(median household income)	-0.284***	-0.311***	-0.284

Table A.14: Regression Result—part 3

	M-1 OLS	M-2 year,state-fixed	M-3 state-fixed
unemployment rate	(-12.30) -0.00166**	(-13.95) -0.000939	(-3.19) -0.00166
Log(GDP)	(-2.94) 0.126*** -10.18	(-1.21) 0.129*** -9.63	(-1.81) 0.126* -6.78
Log(mileage)	-0.0180*** (-4.46)	-0.0231*** (-8.71)	-0.018 (-2.44)
Constant	0.123* -2.37	0.018 -0.25	0.116 -0.68
Observations	294	294	294
Adjusted R-squared	0.835	0.855	0.791

t statistics in parentheses
 * p<0.05, **p<0.01, *** p<0.001

Table A.15: Data Source and operation for the empirical test

Variables		Source	Time Period
Dependent Variable	lg(igt)	State CAFR	
Independent Variables	c p	Ballotpedia	
	gdp	FRED	2000-2019 annually collected
	lgp		
Control Variables	wapw mhi	Census of bureau	
	ur		
	prm	Bureau of transportation statistics	

A.4 Chapter 4

A.5 Chapter 5

Table A.16: State Expenditure Purpose and Revenue Source

	General funds	Federal funds	Other State funds	Bond funds	<i>Expenditure Purposes</i>
<i>Revenue Source</i>	State	Federal	State	_____	
Elementary & Secondary Education					W
Higher Education					W
Temporary Assistance for Needy Families					W
Other Cash Assistance					W
Medicaid Total Funds					W
Corrections					W
Transportation					P
Housing Capital					P
Environmental Capital					P

Table A.17: Tax handle variables to predict the tax revenue

Abbreviation	Meaning
agrr	Ratio of agriculture to gdp
minr	Ratio of mining to gdp
manr	Ratio of manufacturing to gdp
tandwr	Ratio of transportation and warehouse to gdp
infr	Ratio of information to gdp
fandir	Ratio of finance and insurance to gdp
rer	Ratio of real estate to gdp
hsr	Ratio of health care and social assistance to gdp
piepcm	per capital income spend on expenditure
trader	Ratio of trade to gdp
pster	Professional, scientific, educational, and technical services
mehim	Median household income
unemployrate	unemployment rate
gdp	GDP per capita

Table A.18: DF test results for variables in state of America

geoname	level_1	taxreveneratio	agr	minr	manr	tandwr	infr	fandir	rer	hsr	piepcm	trader	pster	mehim	unemployrate	gdppercapita
Alabama	ADF Statistic	-2.9584957	-4.0738483	-2.1262916	-3.7780187	-2.3795241	-4.5285992	-2.8465617	-3.3691314	-6.6545878	-2.3099791	-0.354905	-4.7383288	-5.2118955	-2.5388273	-2.4977533
Alabama	P-value	0.1440567	0.0068865	0.531346	0.0177068	0.3905597	0.0013549	0.1803687	0.0556509	8.41E-08	0.4284382	0.9881567	0.0005996	8.32E-05	0.3088295	0.3290865
Alaska	ADF Statistic	-2.0826184	-3.1155341	-3.7940843	-3.3981553	-6.4811537	-2.6940316	-4.9448154	-4.5470878	-5.6889734	-3.1354863	-7.3714471	-3.0392903	-1.7603157	-2.7177455	-2.7181459
Alaska	P-value	0.5558153	0.1025832	0.0168025	0.0516349	2.03E-07	0.238569	0.000259	0.0012629	9.64E-06	0.0980398	2.01E-09	0.1214254	0.7235718	0.2287886	0.2286257
Arizona	ADF Statistic	-3.8693215	-4.6322823	-1.7101206	-0.3743152	-7.5316714	-4.4778336	-4.1707467	-5.3301527	-2.5375428	-2.0054682	-2.3710659	-3.7761038	-6.1423639	-1.9470851	-2.5295149
Arizona	P-value	0.0133634	0.0009099	0.7464038	0.9876256	8.62E-10	0.0016406	0.0049542	4.95E-05	0.3094533	0.5984518	0.3951099	0.0178099	1.10E-06	0.6299357	0.0133664
Arkansas	ADF Statistic	-3.8144652	-3.2574705	-3.3138418	-3.2526213	-2.6120583	-3.0102396	-5.2714893	-1.9617547	-3.8065392	-2.8672628	0.7610834	-3.8232961	-7.2296709	-1.8315081	-2.9306735
Arkansas	P-value	0.0158476	0.0735461	0.0640084	0.0744169	0.2747374	0.1292407	6.41E-05	0.6221029	0.0134803	0.1733367	1	0.0154179	4.25E-09	0.6893708	0.1525052
California	ADF Statistic	-3.3335918	0.7247841	-5.2060476	-2.2999803	-3.9951928	-1.4944674	-3.301189	-5.0087446	-5.1396849	-2.3659968	-2.8818869	-6.3344666	-2.2391546	-2.2533527	-2.8013711
California	P-value	0.0609133	1	8.53E-05	0.4339608	0.008933	0.8310186	0.0660573	0.0001983	0.0001137	0.3978451	0.1684937	0.027052	0.4678524	0.4599033	0.1964413
Colorado	ADF Statistic	-7.6191717	-3.3285227	-0.8284793	-2.0928674	-2.7511687	-2.1354386	-4.6806141	-2.6886979	-4.714105	-2.3839804	-1.2484704	-3.8171345	-4.353958	-2.0836961	-2.559226
Colorado	P-value	5.42E-10	0.0616959	0.9631981	0.5500885	0.2154567	0.5262035	0.0007533	0.2408052	0.0006601	0.3881694	0.9000907	0.0157131	0.0025905	0.5552137	0.2990106
Connecticut	ADF Statistic	0.105427	-5.614409	-2.6514881	-3.7322998	-3.3657117	-2.1895655	-3.9815021	-2.9085756	-3.7505465	-2.7743348	-2.5193086	-3.2045364	-2.5030802	-3.7037153	-4.7590079
Connecticut	P-value	0.9951566	1.36E-05	0.2567715	0.0203164	0.0561405	0.495725	0.0093407	0.1594584	0.0192371	0.2065306	0.3183769	0.0835016	0.326424	0.0221138	0.0005522
Delaware	ADF Statistic	-3.1393466	-3.3145667	-4.9336125	-3.2188079	-0.7223429	-2.303585	-0.6156446	-3.3056062	-4.247519	-2.7340805	-3.7018074	-5.8610316	-4.7405574	-3.2199067	-10.574293
Delaware	P-value	0.0971789	0.0638926	0.0002713	0.0807187	0.9716374	0.431968	0.9781385	0.0653361	0.0037908	0.2222062	0.0222385	4.28E-06	0.0005943	0.0805073	1.51E-16
Florida	ADF Statistic	-4.8669747	-2.7072056	-4.2669358	-5.5067657	-2.6650288	-0.4769127	-1.9741621	-3.3385817	-3.0333683	-3.0453498	-2.4700988	-5.2022004	-2.136408	-2.542309	-2.5571086
Florida	P-value	0.0003569	0.2331029	0.0035394	2.23E-05	0.2508878	0.9843121	0.6154352	0.0601509	0.1229896	0.1198402	0.3430694	5.85E-05	0.5256582	0.307142	0.3000221
Georgia	ADF Statistic	-1.3862558	-3.9642423	-1.5570629	-3.974274	-1.4218962	-1.0532807	-2.1118196	-3.6462642	-4.011087	-2.0314994	-3.7304951	-2.7878658	-2.8849757	-2.4816295	-0.3230385
Georgia	P-value	0.8649024	0.0098784	0.8085722	0.0095626	0.8543696	0.9365038	0.5394719	0.0261488	0.0084799	0.5814755	0.020426	0.2014369	0.1674839	0.3372069	0.9889707
Hawaii	ADF Statistic	-3.2823748	-3.4492431	-2.0175917	-0.9805192	-4.2261142	-3.5853585	-4.2564581	0.1945429	-2.9148399	-1.8186507	-3.3759258	-1.5834406	-0.9607372	-3.2727731	-2.0802754
Hawaii	P-value	0.0692012	0.045148	0.591819	0.9466804	0.0040869	0.0312658	0.0036731	0.0957462	0.1574654	0.6956964	0.0546885	0.79885	0.9491729	0.0708514	0.5571229
Idaho	ADF Statistic	-4.272711	-3.4487125	-1.8967678	-3.0275766	-3.109667	-2.7050241	0.1819603	-2.7692856	-4.7744075	-2.9283954	0.1210051	-3.6201161	-11.799223	-2.9882011	-3.5448589
Idaho	P-value	0.0034676	0.0452117	0.6536424	0.1245337	0.1039492	0.2340024	0.0956721	0.2084541	0.0005192	0.153212	0.995271	0.0281867	8.23E-19	0.1354096	0.0348303
Illinois	ADF Statistic	2.2055768	-4.5868314	-2.9059329	-2.9685475	-4.9050819	-4.0010139	-3.1577302	-4.0337167	-3.3683733	-2.8416788	-2.1620797	-4.5311699	-4.8661301	-2.6609907	-3.1650605
Illinois	P-value	1	0.0010847	0.1630405	0.1410877	0.0003053	0.0087646	0.0931582	0.0078705	0.0604111	0.1820576	0.5111346	0.0013417	0.0003581	0.2526337	0.0915913
Indiana	ADF Statistic	-5.1574461	-5.7155784	-2.1507255	-6.477512	-3.06508	-5.2218945	-7.0097004	-6.1401189	-7.8039373	-2.436235	-2.3102721	-3.0872072	-7.023714	-2.9533594	-3.6019904
Indiana	P-value	0.0001053	8.51E-06	0.5170008	2.06E-07	0.1147847	7.936E-05	1.34E-08	1.11E-06	2.03E-10	0.3605396	0.4282766	0.1093063	0.9729916	0.1455909	0.0296783
Iowa	ADF Statistic	-6.0901826	-4.3927572	-2.4832443	-7.0679353	-2.6322937	-1.9978792	-5.5354435	-3.1579108	-4.6701772	-3.2590251	-3.2725052	-2.7406905	-6.0708915	-2.9988559	-4.9323914
Iowa	P-value	1.42E-06	0.0022487	0.3363895	9.91E-09	0.2652539	0.6025886	1.96E-05	0.0931194	0.0007848	0.0732687	0.0708978	0.2195788	1.56E-06	0.1324011	0.0002727
Kansas	ADF Statistic	-2.5665144	-3.1387984	-1.2040844	0.61863	-2.9471436	-4.2537381	-2.7062164	-2.4390351	-0.5887284	-3.0432453	-2.7899665	-4.5161056	-3.8964404	-2.7820881	-4.1499461
Kansas	P-value	0.295427	0.0973008	0.9096626	0.9970018	0.1474629	0.0037083	0.2335105	0.3590813	0.9795168	0.120389	0.2006541	0.0014205	0.0122702	0.2036011	0.0053214
Kentucky	ADF Statistic	-3.7910525	-2.556417	-4.9316617	-2.4623514	-3.140775	-2.6790055	-2.6041511	-3.3248058	-0.7279646	-2.8402648	-2.0194022	-6.6672932	-4.0015556	-2.519608	-4.1190233
Kentucky	P-value	0.0170191	0.3003528	0.0002735	0.3470336	0.0968618	0.2449027	0.2779856	0.0622749	0.9712438	0.1825489	0.590826	0.9752111	0.008749	0.3182293	0.0059134
Louisiana	ADF Statistic	-3.4668779	-7.3993455	-5.0297387	-3.123526	-2.0422269	0.5809776	-2.7602631	-3.158981	-4.0690225	-2.6377381	-2.5084001	-1.8975846	-3.0377071	-1.4466776	-3.5362443
Louisiana	P-value	0.0430729	1.74E-09	0.0001816	0.1007445	0.5782566	0.9969685	0.2119217	0.0928894	0.0069986	0.2628312	0.3237753	0.6559199	0.1218422	0.8466851	0.0356696

Table A.19: Tax handle regression results for regions in America

	Far West	Great Lakes	Mideast	New England	Plains	Rocky Mountain	Southeast	Southwest
agrr	0.314 -0.27	0.391 -1.06	0.478 -0.74	1.169 -1.55	0.038 -1.18	-0.115 (-0.44)	0.0381 -0.29	0.69 -1.53
minr	0.185 -1.87	0.031 -0.08	0.653 -1.91	-0.248 (-0.28)	0.156 -0.87	-0.0348 (-1.15)	0.0343 -0.48	0.0859 -1.24
manr	-0.0354 (-0.30)	0.0383 -0.77	-0.0819 (-0.97)	0.0375 -0.74	-0.130** (-3.03)	0.0179 -0.16	0.0746 -1.04	-0.0132 (-0.31)
tandwr	1.674*** -22.19	1.493*** -27.17	1.205*** -4.2	-1.131* (-2.29)	-0.138 (-0.89)	0.12 -0.39	1.092*** -22.7	0.17 -0.89
infr	-0.16 (-0.62)	-0.28 (-0.79)	-0.0533 (-0.65)	-0.0324 (-0.24)	-0.0277 (-0.38)	0.061 -0.24	-0.0518 (-0.32)	-0.362* (-2.41)
fandir	1.133* -2.76	-0.109 (-0.72)	-0.0168 (-0.37)	0.0688 -1.65	0.0799* -2.78	-0.268 (-1.00)	-0.541*** (-23.22)	0.0148 -0.08
rer	-0.069 (-0.43)	0.00559 -0.84	-0.120** (-2.94)	0.161* -2.26	0.189*** -4.71	-0.0876 (-1.24)	-0.0218 (-0.57)	0.158*** -5.85
hsr	-3.223** (-3.17)	0.262 -0.82	-0.0815 (-1.19)	0.317** -3.23	-0.0291 (-0.09)	1.138* -2.23	0.756*** -28.81	-1.326* (-2.19)
piepcm	0.017 -0.3	0.022 -0.97	0.00506* -2.66	0.00597 -0.71	0.00863 -0.4	-0.00616 (-1.46)	0.00248* -2.24	0.0329 -1.17
trader	0.818* -2.63	0.0534 -0.29	-0.155** (-3.57)	-0.105 (-0.88)	0.0846 -0.46	-0.203* (-2.14)	-0.0765 (-2.06)	-0.209*** (-7.11)
pster	-0.45 (-1.02)	0.0163 -0.89	0.0194 -0.21	0.189 -1.86	0.507 -1.88	-0.137 (-0.43)	0.788*** -35.78	-0.146 (-0.59)
mehim	-0.00209 (-0.90)	0.000118 -0.11	-0.00259* (-2.28)	0.00166 -1.61	0.00102 -0.79	0.00367* -2.44	-0.00033 (-2.03)	-0.00409*** (-6.63)
unemployrate	0.00127 -1.25	0.00147 -1.56	0.00128* -2.75	0.000011 -0.01	0.00227 -1.65	0.00185 -1.92	0.000567** -3.52	0.00187* -2.66
gdppercapita	0.0295*** -5.38	-0.00041 (-0.89)	0.00397*** -4.2	0.000235 -0.32	0.00632*** -7.52	0.00113 -0.22	0.000338 -1.25	-0.0353** (-3.52)
Constant	-0.00177 (-0.33)	-0.00194 (-0.80)	0.0201* -2.72	-0.0149* (-2.76)	-0.00177 (-0.86)	0.0147 -0.64	-1.5E-05 (-0.02)	0.0247*** -5.27
Observations	98	93	87	86	117	79	210	68
Adjusted R-sq	0.882	0.982	0.988	0.979	0.963	0.893	0.958	0.98

t statistics in parentheses

*p<0.05, **p<0.01, ***p<0.001

Table A.20: B-W heteroskedasticity test result for measurement equation regression

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
Ho: Constant variance
Variables: residuals
chi2(1) = 0.88
Prob > chi2 = 0.3491

Table A.21: Summary of the tax effort level in states(part)

State	Obs	Tax collection effort			
		Mean	Std.	Min	Max
Alabama	17	0.99108	0.10704	0.77345	1.12369
Alaska	18	1.15363	0.63936	-0.0749	2.9033
Arizona	15	0.9645	0.10226	0.80104	1.19916
Arkansas	15	0.97468	0.12192	0.85674	1.20869
California	19	1.05056	0.16872	0.53894	1.23222
Colorado	19	1.01097	0.10623	0.8695	1.26189
Connecticut	19	0.73208	0.08448	0.6359	0.90594
Delaware	14	1.08929	0.09726	0.90916	1.2335
Florida	19	1.09674	0.16283	0.87646	1.49477
Georgia	19	0.99922	0.1371	0.74665	1.34715
Hawaii	14	0.97187	0.15959	0.69107	1.18888
Idaho	19	0.91308	0.11257	0.73638	1.18433
Illinois	19	1.00037	0.1077	0.82428	1.26365
Indiana	17	1.00917	0.07028	0.85208	1.13589
Iowa	17	8.06824	1.30505	5.15989	9.82793
Kansas	19	1.23506	0.18167	0.9192	1.70648
Kentucky	19	0.9929	0.08475	0.87784	1.25705

Table A.22: Regression result of intergovernmental transfer on state tax collection effort

	OLS	Two factors fixed effect		
	model-1	model-2	model-3	model-4
agrr	102.6*** -15.11	102.6*** -15.11	19.32 -1.63	19.32 -1.63
minr	4.513*** -3.93	4.513*** -3.93	-2.888* (-2.20)	-2.888* (-2.20)
manr	-2.163*** (-3.31)	-2.162*** (-3.31)	0.41 -0.48	0.409 -0.47
infr	4.669** -2.96	4.669** -2.96	1.85 -0.58	1.843 -0.58
fandir	11.21*** -8.97	11.21*** -8.97	0.0485 -0.01	0.0543 -0.02
rer	3.301*** -7.44	3.301*** -7.44	2.768 -0.69	2.766 -0.68
piepcm	-0.677*** (-10.67)	-0.677*** (-10.67)	-0.12 (-0.89)	-0.12 (-0.88)
mehim	-0.0499*** (-6.14)	-0.0499*** (-6.14)	-0.0303 (-1.28)	-0.0302 (-1.27)
unemployrate	-0.0192* (-2.07)	-0.0192* (-2.07)	0.0248 -1.59	0.0247 -1.59
gdppercapita	0.120*** -6.37	0.120*** -6.37	0.396 -1.72	0.396 -1.72
constraintratio	-45.98* (-2.32)		-14.38* (-2.56)	
sw_preference	-9.181** (-2.61)	76.42* -2.18	-1.806* (-2.07)	21.61* -2.23
int_cons_pref	70.57* -2.22		19.25* -2.22	
generalratio		56.28* -2.32		17.64* -2.57
int_gen_pref		-86.39* (-2.22)		-23.64* (-2.23)
Constant	6.760** -3.11	-49.00* (-2.24)	2.070** -2.91	-15.40* (-2.41)
Observations	834	834	834	834
Adjusted R-sq	0.714	0.714	0.594	0.594

t statistics in parentheses

*p<0.05, **p<0.01, ***p<0.001

Table A.23: Variables, measurement and data source

Variables and Abbreviation		Meaning	Data Source	Time Period
Control Variables	Agriculture	agr	Industrial gdp Bureau of Economic Analysis	2000-2019
	Mining	minr		
	Manufacturing	manr		
	Wholesale trade and Retail Trade	trader		
	Transportation and warehousing	tandwr		
	Information	infr		
	Finance and insurance	fadir		
	Real estate and rental and leasing	rer		
	Health care and social assistance	hsr		
	Professional, scientific, educational, and technical services	pster		
	Median household income	mehi		
	Unemployment rate	unemployrate		
independent variable	person income expenditure per capita	iepcm	FRED Data Base	2000-2019
	GDP per capita	gdp		
	Welfare spending preference	w_preference		
	general ratio	gen_ratio	Federal grants ratio with no constraints	State Expenditure Annual Report
	productive spending matching ratio	cons_ratio		

Appendix B |

Figures

B.1 Chapter 1

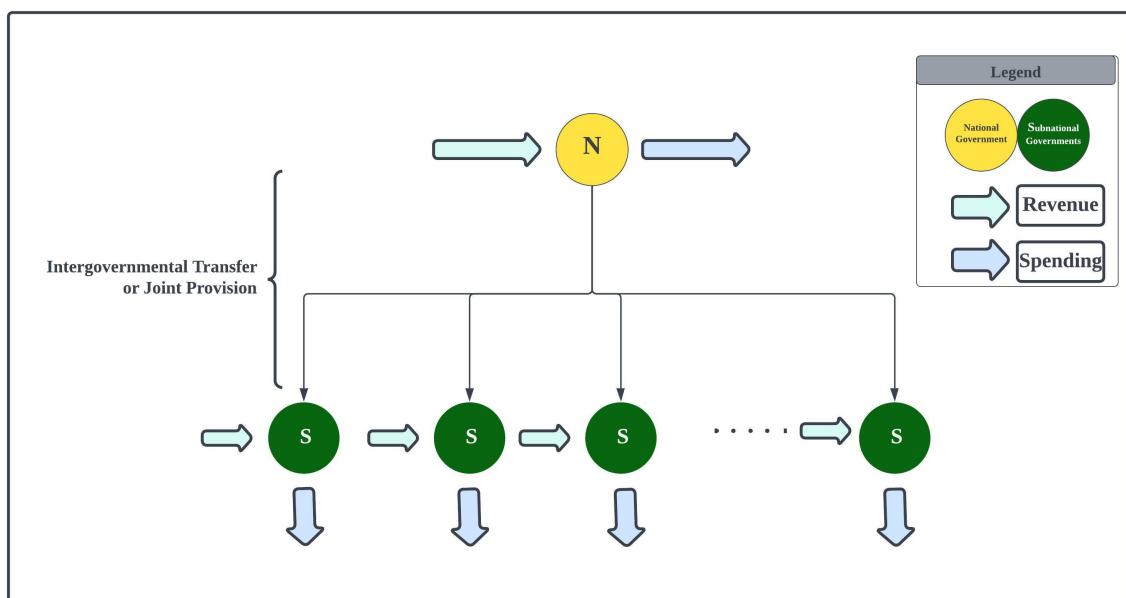
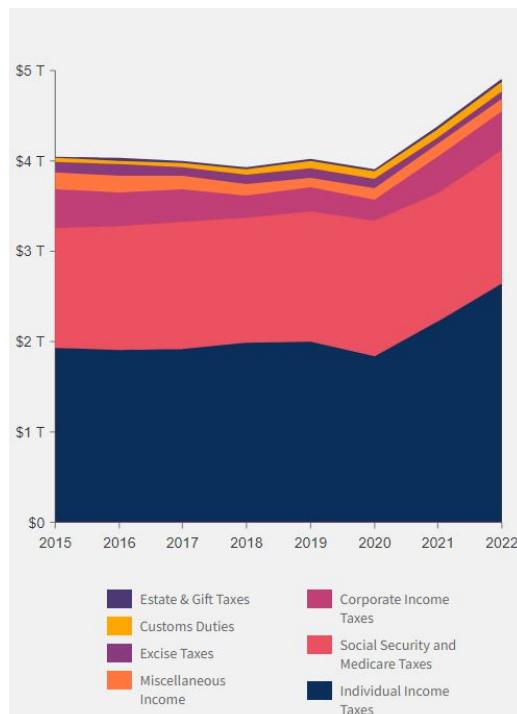
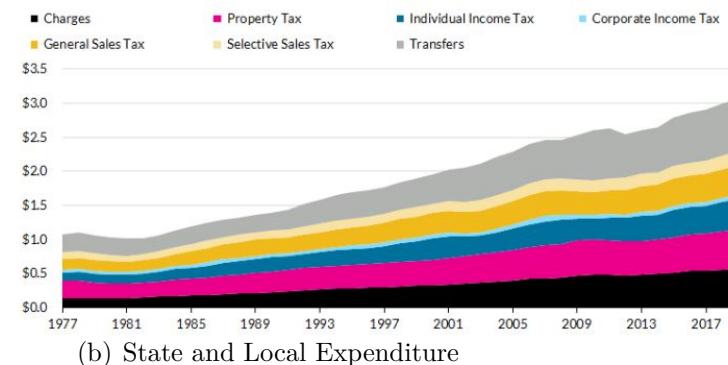


Figure B.1: Fiscal Federalism Structure



(a) Federal Expenditure



(b) State and Local Expenditure

Figure B.2: Fluctuation of Revenue Structure of three level governments. Data Source: US Urban Institute Dataset

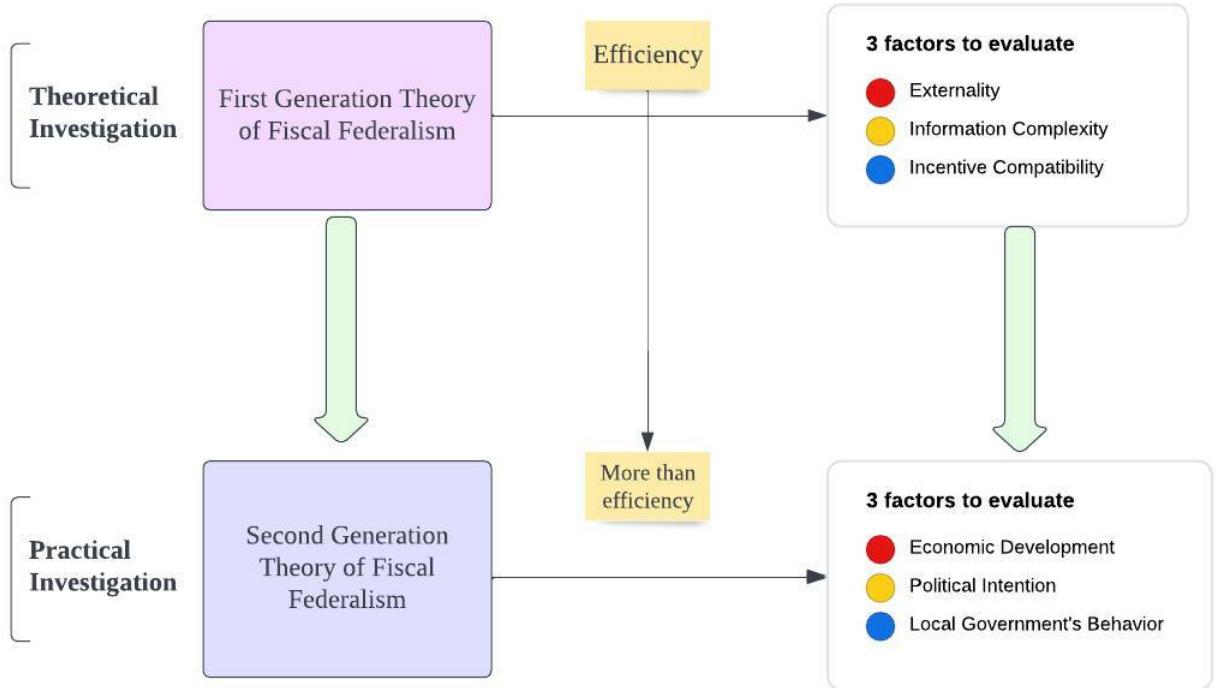


Figure B.3: How to evaluate the fiscal federalism

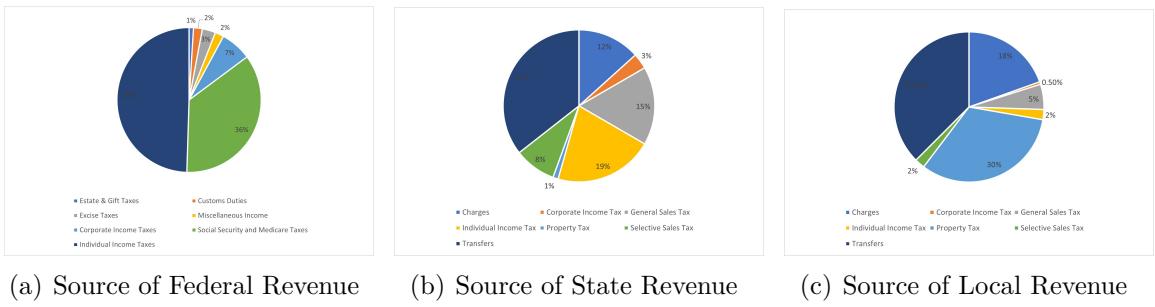


Figure B.4: Source of Revenue for Multiple Level of Governments

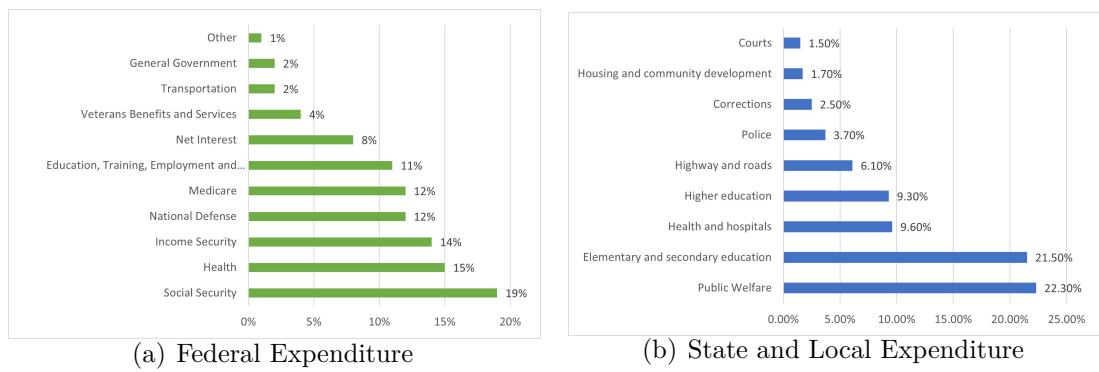


Figure B.5: Expenditure Structure for Multiple Level of Governments.

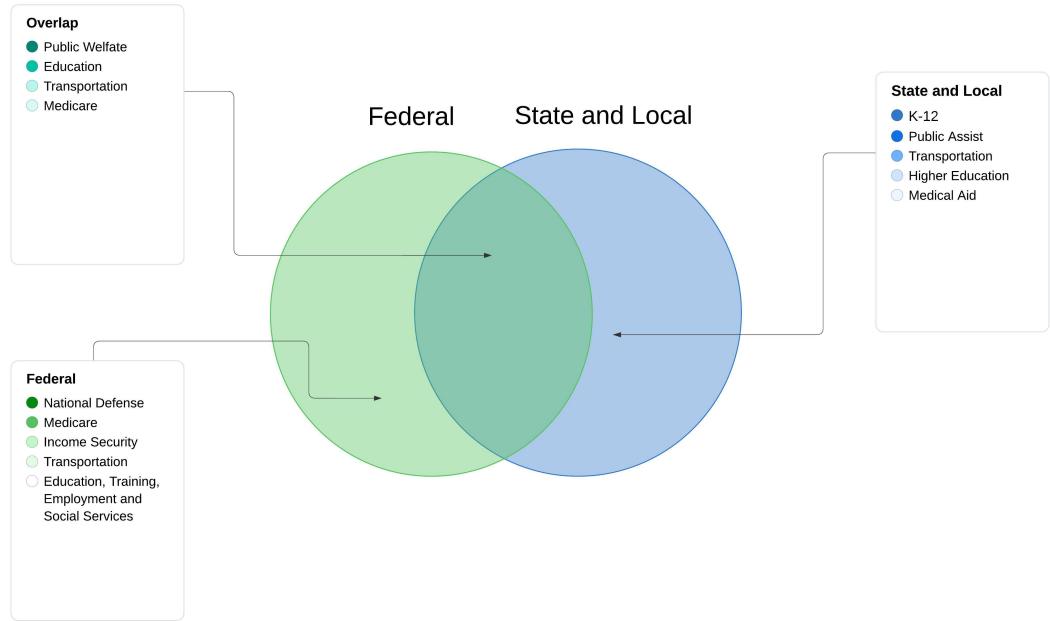


Figure B.6: Venn graph on public goods and services supplying by federal, states and local government

B.2 Chapter 2

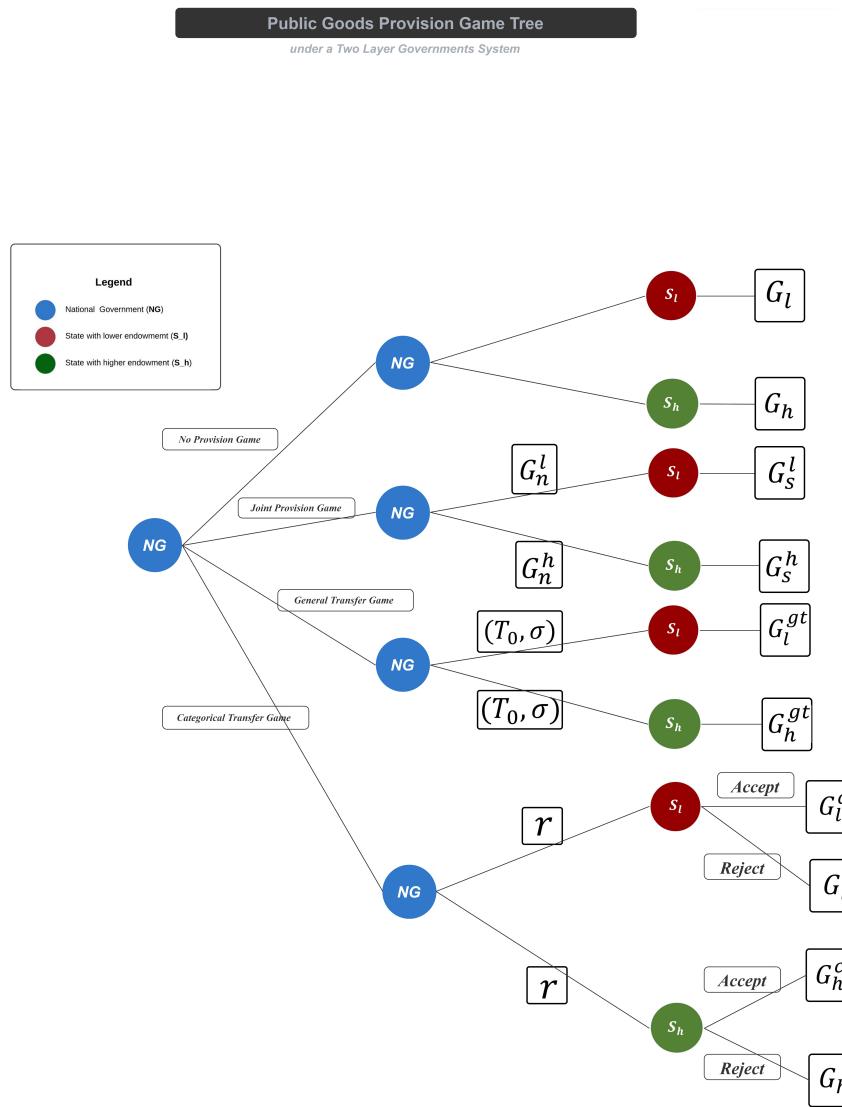
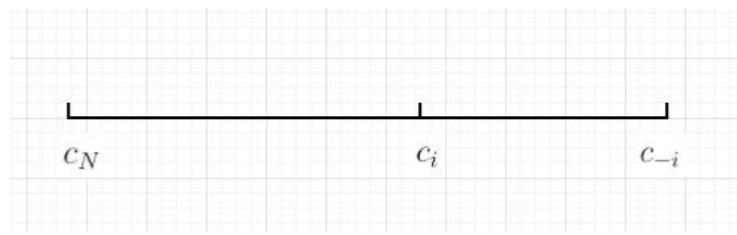
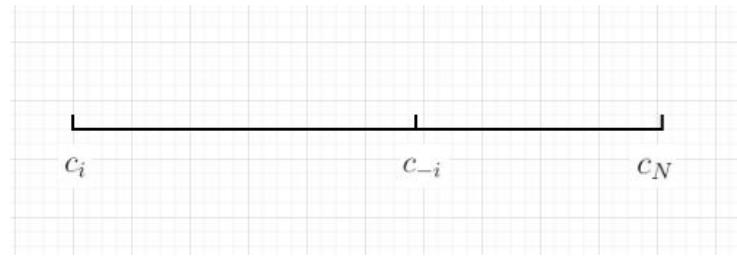


Figure B.7: Dynamic Game Tree between Central and Subnational Governments

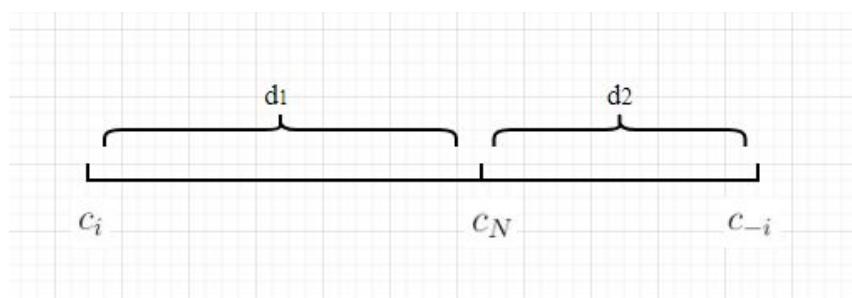


(a)

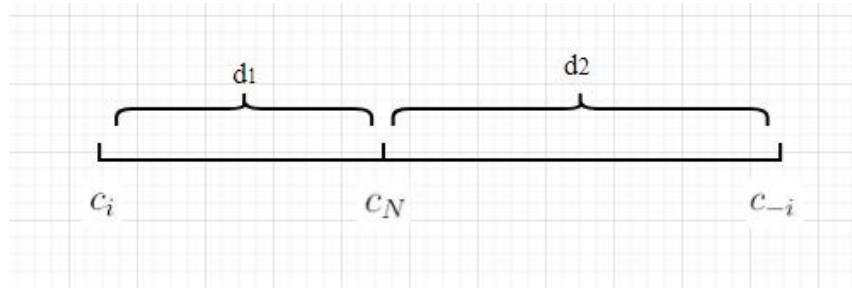


(b)

Figure B.8: When c_N lies outside the range of c_i and c_{-i}



(a)



(b)

Figure B.9: When c_N lies between c_i and c_{-i}

B.3 Chapter 3

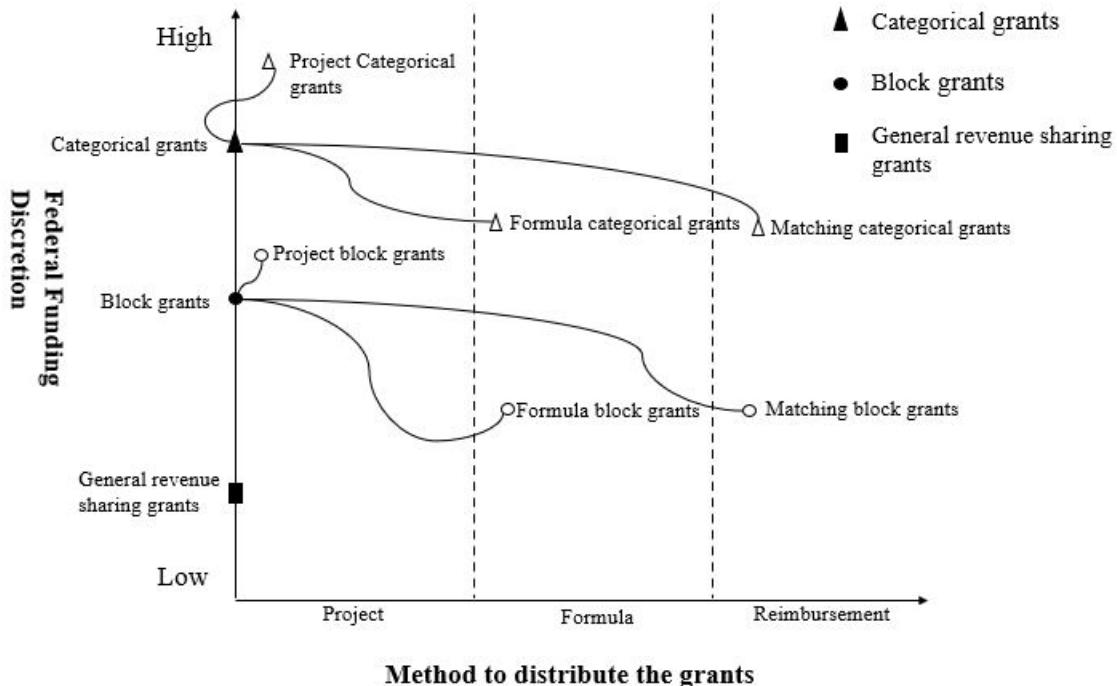


Figure B.10: Grants Type in America

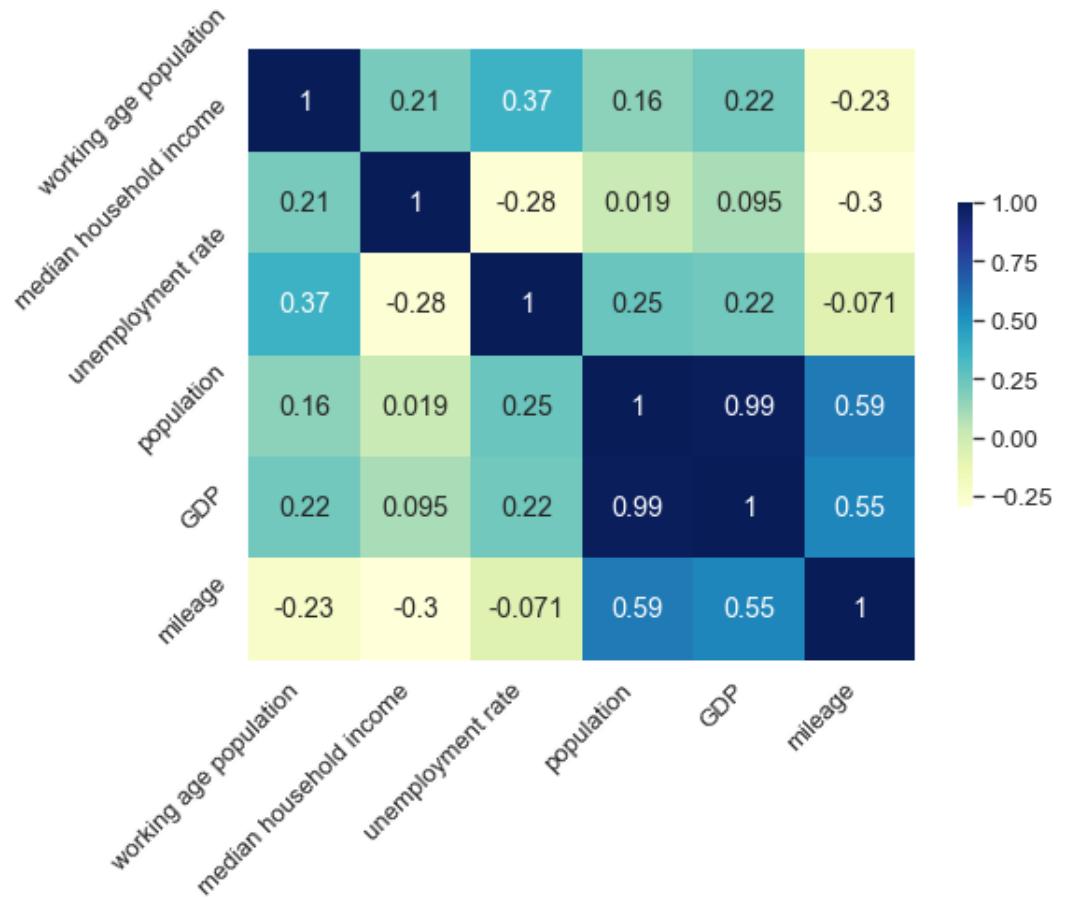


Figure B.11: Heatmap of the Social Characteristics

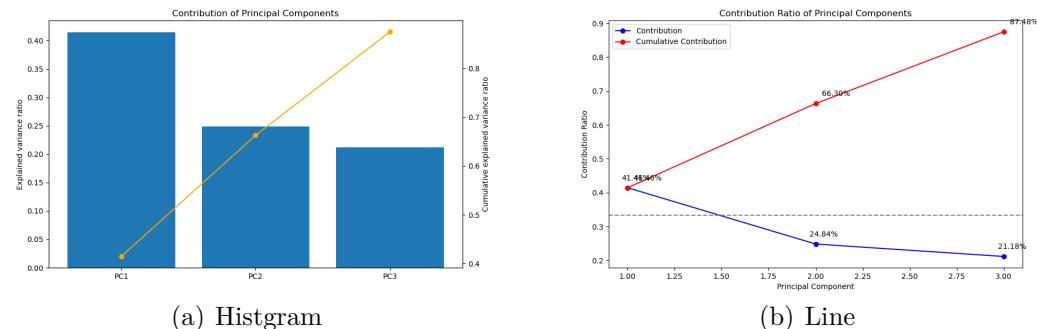


Figure B.12: Principle Components Contribution

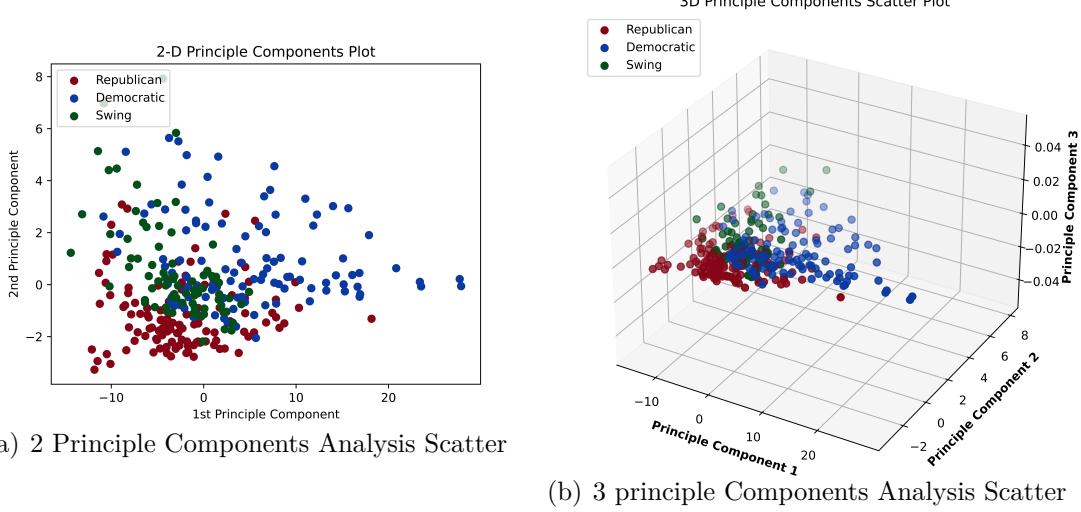


Figure B.13: Social Characteristics Principle Components Analysis Scatter Plot

Relationship between IGT proportion and Factors



Figure B.14: Factor and IGT Scatter Plot

B.4 Chapter 4

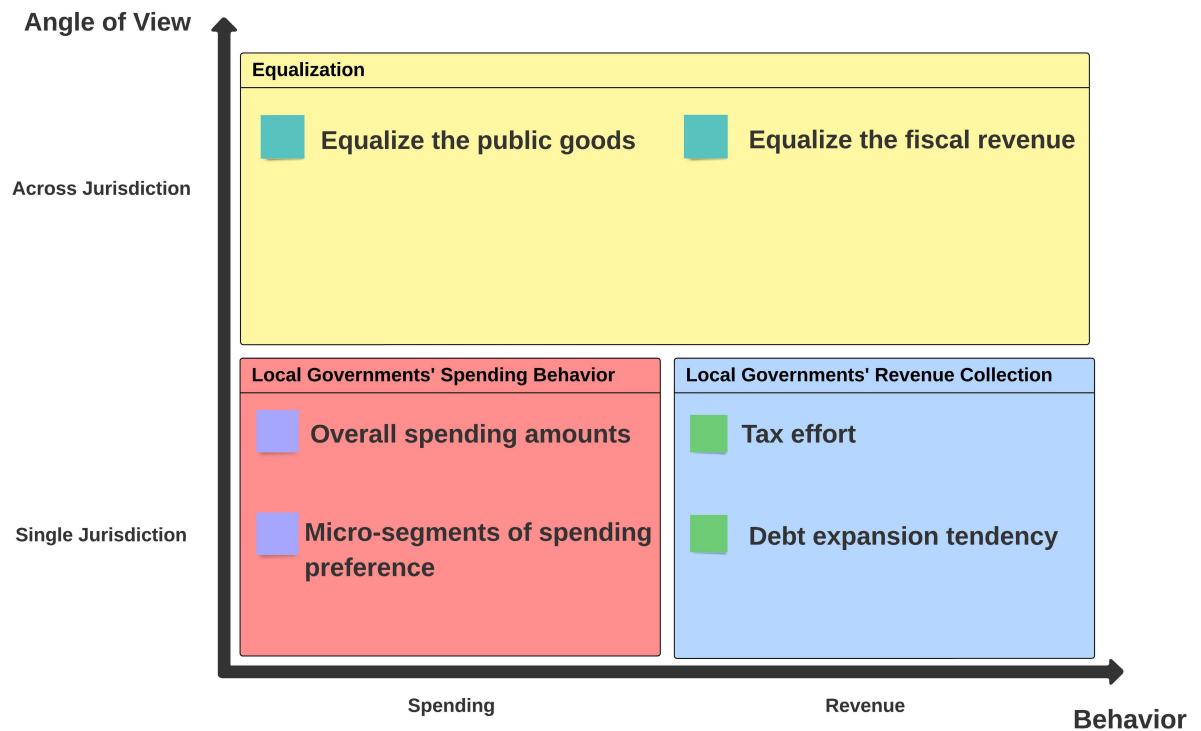


Figure B.15: Effect of Intergovernmental Transfer

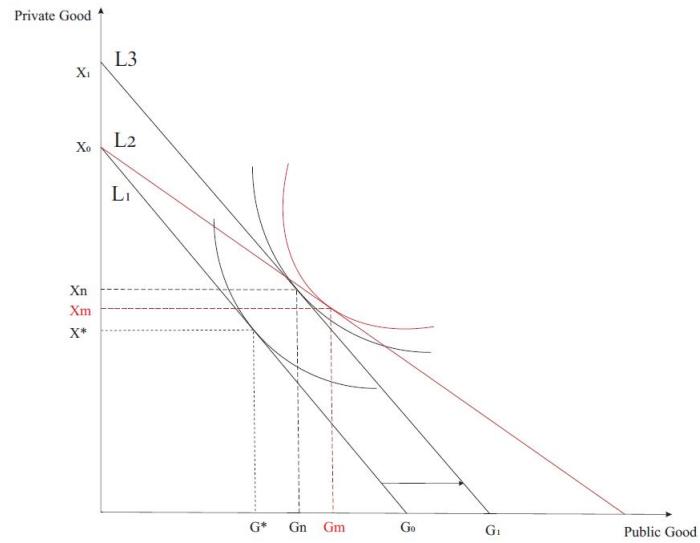


Figure B.16: Income Effect and Price Effect of Matching and Non-matching Grants

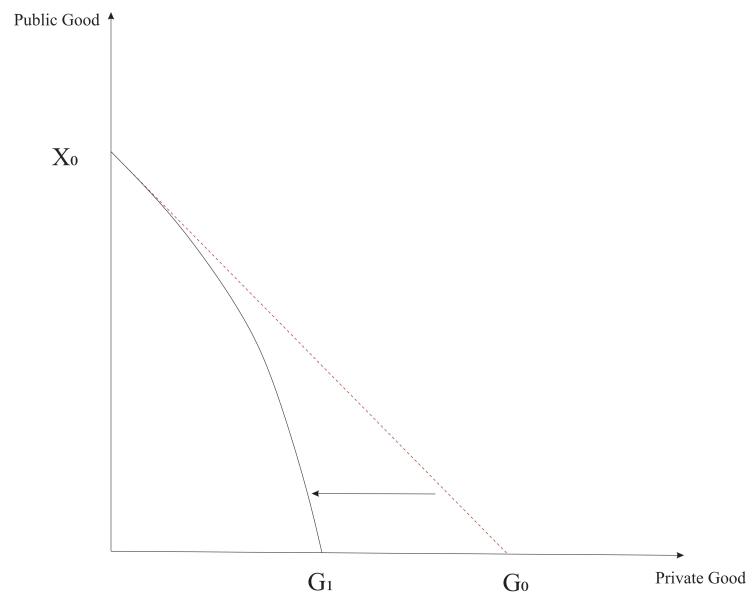


Figure B.17: Hamilton's Curved Budget Constrain

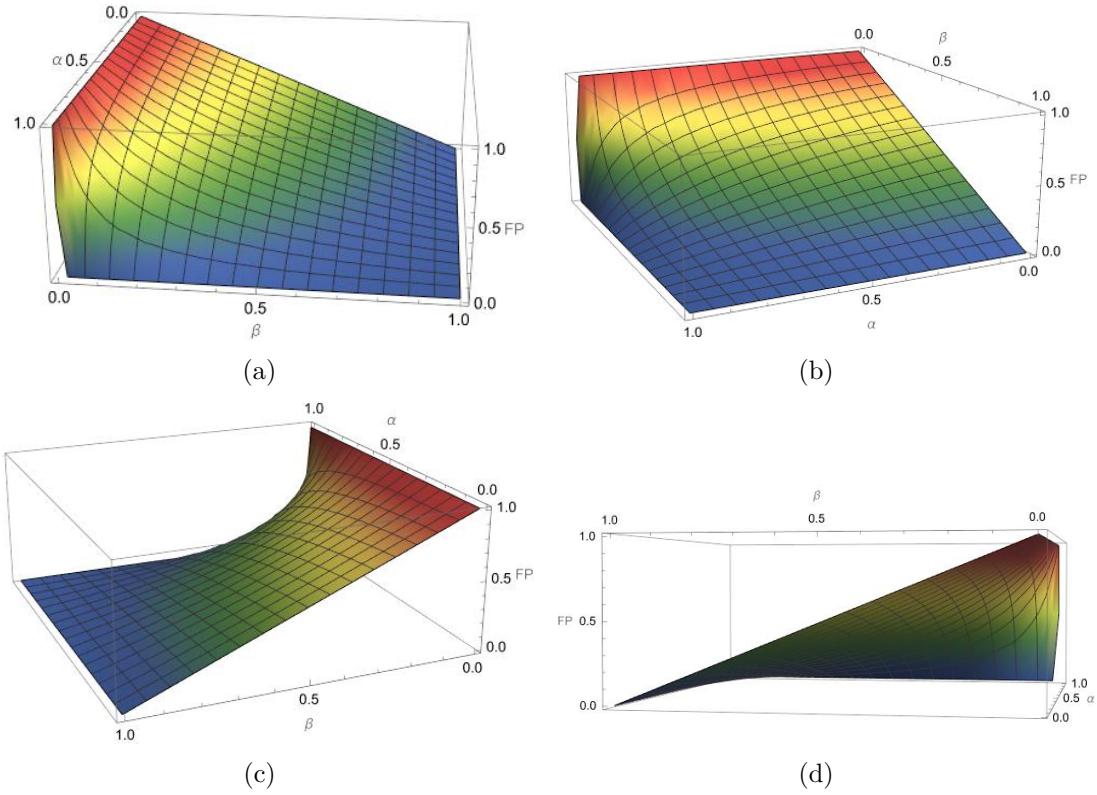


Figure B.18: 3-Dimensions Plot of the Fluctuation of Flypaper Effect under Distortion

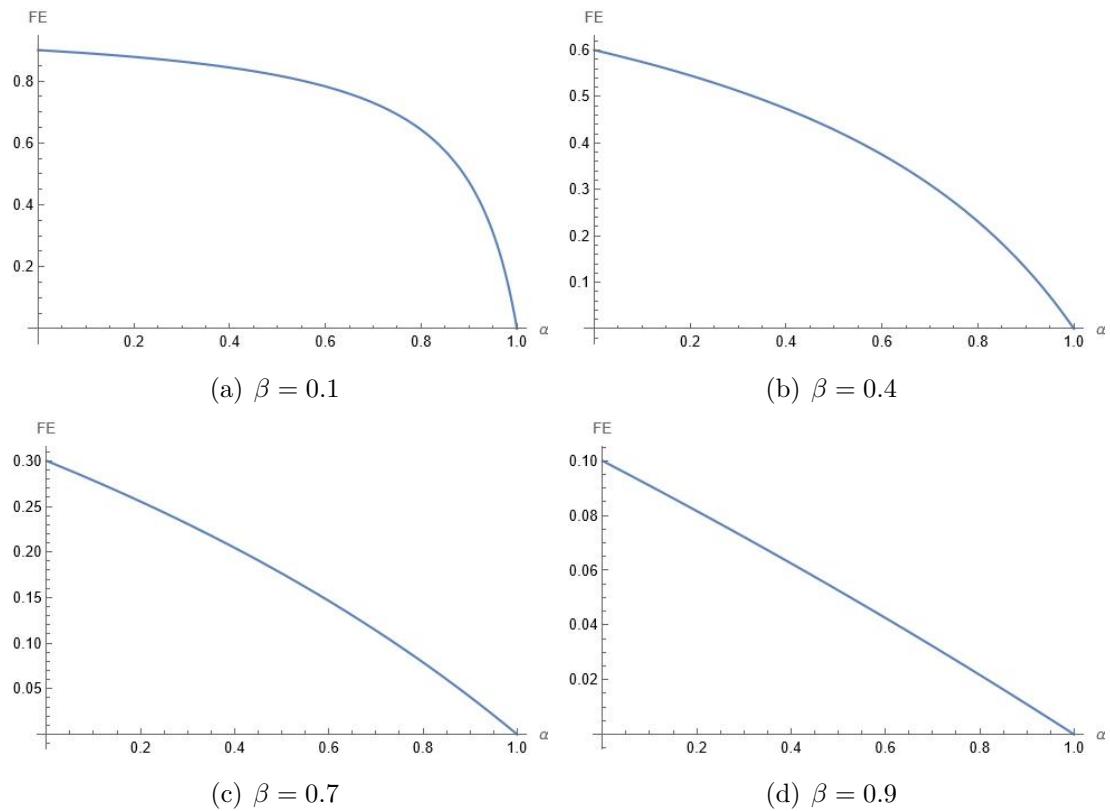


Figure B.19: 2-Dimensions Plot of the Fluctuation of Flypaper Effect on α

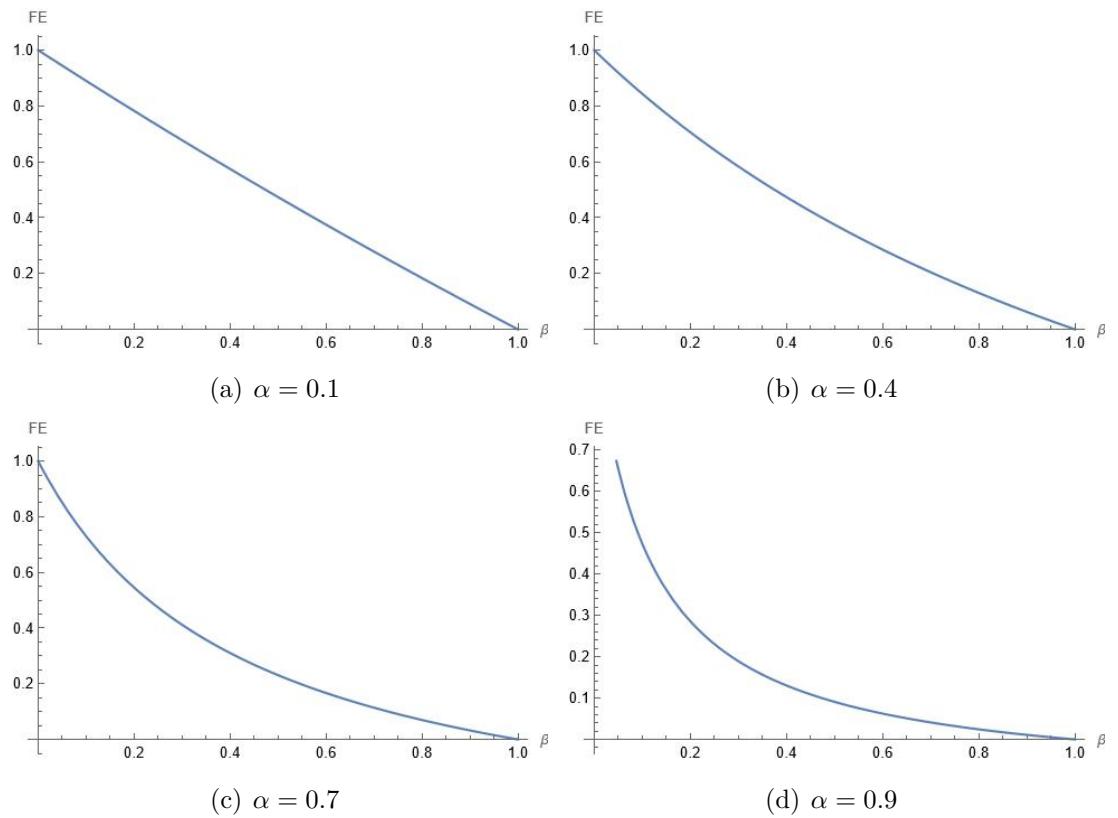


Figure B.20: 2-Dimensions Plot of the Fluctuation of Flypaper Effect on β

B.5 Chapter 5

$$\begin{aligned}
& - \frac{1}{\theta(n-1)\tau(\lambda(\alpha(-\sigma) + \alpha + e\tau - 1) + n(e\tau - 1) - e\tau + 1)} ((\alpha - 1)\alpha)^{-\alpha\theta} A^{-\theta} \beta^{-\beta\theta} (1 - e\tau)^{1-\alpha\theta} \\
& \quad (e\lambda\tau + n(e\tau - 1) - e\tau - \lambda\sigma + 1)^{(\alpha-1)\theta} (A^\theta \beta^{\beta\theta} (1 - e\tau)^{\alpha\theta} (e\lambda\tau + n(e\tau - 1) - e\tau - \lambda\sigma + 1)^{\theta-\alpha\theta} \\
& \quad (\theta(-(1-\alpha)^{\alpha\theta}) \alpha^{\alpha\theta+1} (e\tau - 1) + ((\alpha - 1)\alpha)^{\alpha\theta} (\theta(e\tau - 1) + e\lambda\tau - e\tau - \lambda\sigma + 1) - \\
& \quad n((\theta - 1)(\alpha - 1)\alpha)^{\alpha\theta} - \theta(1 - \alpha)^{\alpha\theta} \alpha^{\alpha\theta+1}) (e\tau - 1)) + \\
& \quad \theta\lambda T(0) (1 - \alpha)^\theta r^{\alpha\theta} (\lambda - \lambda m)^{\beta\theta} (e\lambda\tau + n(e\tau - 1) - e\tau - \lambda\sigma + 1))
\end{aligned}$$

Figure B.21: Expression of $\frac{\partial e_{i,t}}{\partial n}$

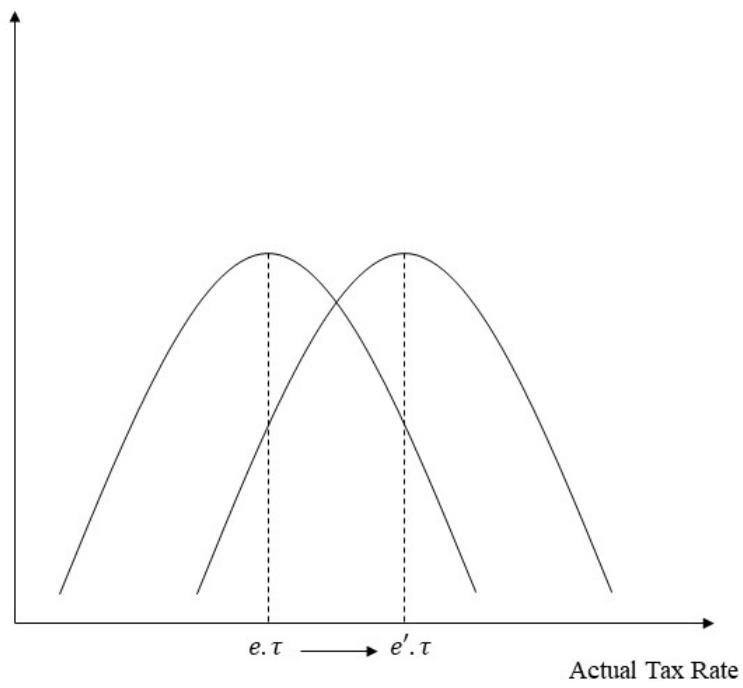


Figure B.22: Laffer Curve for Tax Collection Effort

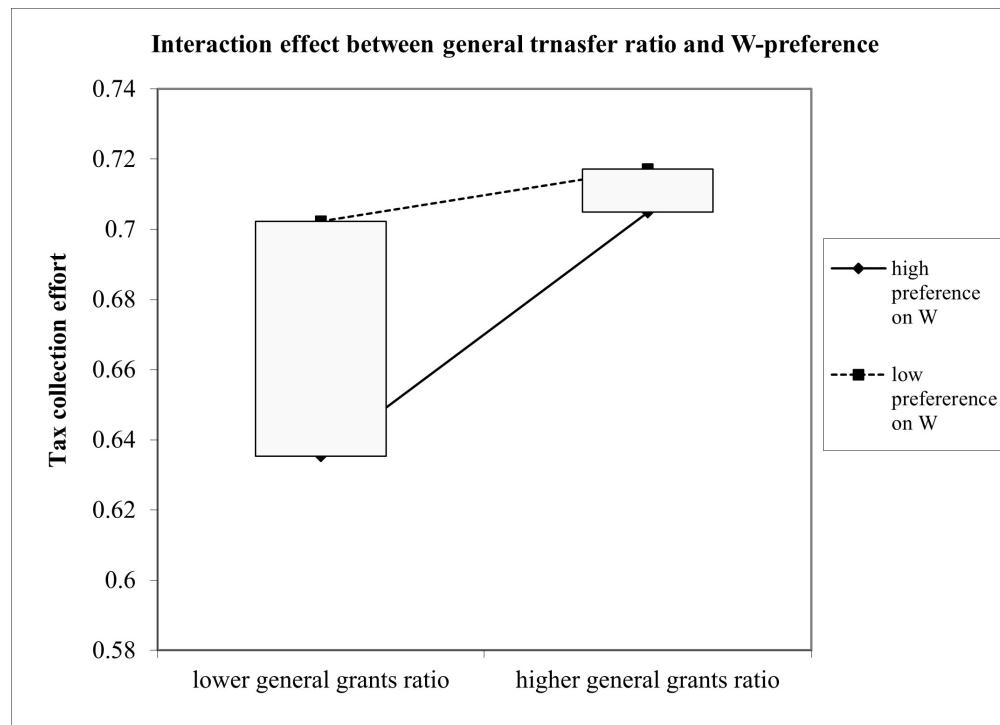


Figure B.23: Interaction effect between general transfer ratio and W-preference

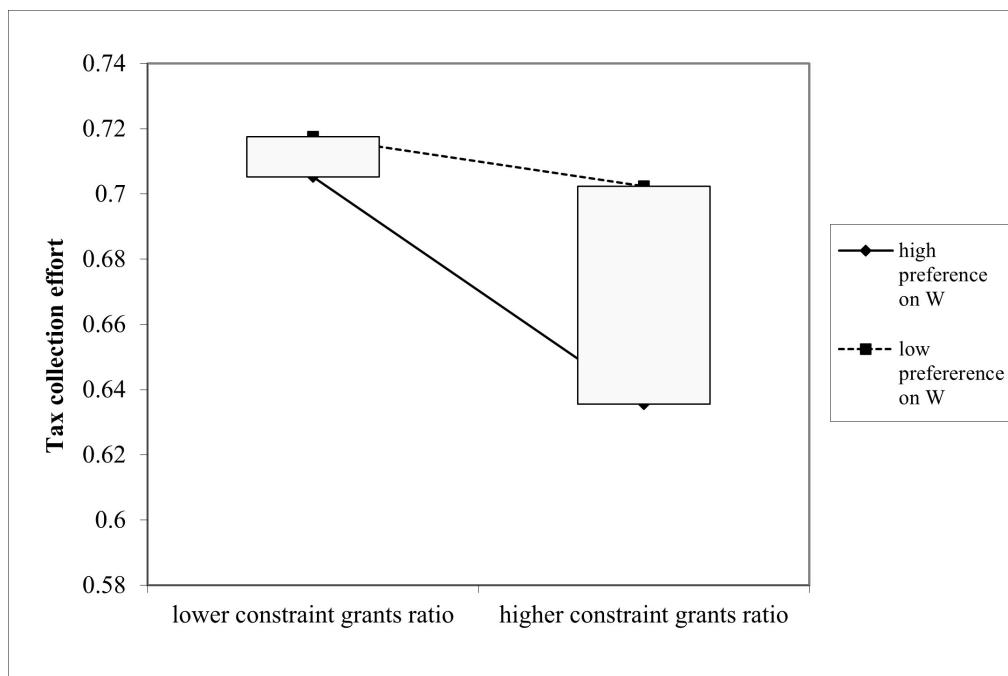


Figure B.24: Interaction effect between productive categorical transfer ratio and W-preference

Appendix C |

Approval Letters from Graduate School

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Vita
Yan Hao

ACADEMIC EMPLOYMENT

Post doctor 2024–
Beijing, China
Peking University, School of National Development

EDUCATION

Doctor of Philosophy in Public Administration 2019–2024
Pennsylvania, America
Pennsylvania State University

Master of Science in Applied Economics 2017–2019
Washington DC, America
The Johns Hopkins University

Bachelor in Economics 2012–2016
Beijing, China
Central University of Finance and Economics

RESEARCH EXPERIENCE

Graduate Research Assistant 2019–2021
Pennsylvania, America
Pennsylvania State University
Professor: Ran Bing, Odd Stalebrink

Research Assistant 2019
Washington DC, America
The Johns Hopkins University
Professor: Sang-Sub Lee

Research Assistant 2019–2021
Beijing, China
Central University of Finance and Economics
Professor: Bai Yanfeng

TEACHING EXPERIENCE

Adjunct Professor 2022
Pennsylvania, America
Pennsylvania State University
Course: International Politics

Adjunct Professor 2022
Pennsylvania, America
Pennsylvania State University

Course: Comparative Politics

Teaching Assistant

The Johns Hopkins University
Course: Econometrics
Professor: Lixiong Li

2017–2018

Washington DC, America

Teaching Assistant

Purdue University
Course: Financial Accounting
Professor: Frank Kane

2018

Beijing, China

Teaching Assistant

Purdue University
Course: Financial Accounting
Professor: Frank Kane

2018

Beijing, China

ACADEMIC CONFERENCE AND PRESENTATION PROCEEDINGS

American Society for Public Administration Conference

Nov 2019

Presenter *Washington D.C, America*
Title: Political Party Control and Intergovernmental Transfer under Fiscal Federalism—a Longitudinal Study

Northeast Conference on Public Administration Conference

Mar 2020

Presenter *New York, America*
Title: Political Party Control and Intergovernmental Transfer under Fiscal Federalism—a Longitudinal Study

American Society for Public Administration Conference

Oct 2021

Presenter *Online, America*
Title: Grants in Aid on Subnational Tax Collection Behavior: an Panel Data Empirical Evidence

PAPERS

Working Paper: Yan Hao, *Intergovernmental Transfer Decision—an Outcome of the Interaction between Central and Local Government*

Working Paper: Odd Stalebrink, Yan Hao, *Political Party Control and Intergovernmental Grants: a Panel Data Analysis*

Working Paper: Yan Hao, *Effect of Grants Restriction on Subnational Governments' Revenue Collection Effort—a Kalman Filter Application*