

FISCAL DECENTRALIZATION: A POLITICAL ECONOMY
APPROACH

A Master's Thesis

by

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July 2013

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ABSTRACT

FISCAL DECENTRALIZATION: A POLITICAL ECONOMY APPROACH

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This study presents a theoretical approach to analyze income and welfare implications of fiscal decentralization in a static closed economy model where political factors are taken into account. We provide two alternative Scenarios: in one scenario government acts like a social planner and solves optimally for the level of fiscal decentralization; in the other scenario government is politically oriented and solves for the optimal tax rate. Under both scenarios we obtain non-cooperative solutions resulting from the interactions of the central government with local governments. Comparative statics of the model provide explicit solutions which enable us to derive policy implications. In order to get a better and deeper insight on the model, we also perform calibration and simulation analyses. We observe that benevolent government enhances social welfare whereas Leviathan CG enhances efficiency, measured by effective tax collection.

Keywords: Fiscal Decentralization, Political Economy, Welfare

ÖZET

MALİ YERELLEŞME: POLİTİK EKONOMİ YAKLAŞIMI

Aslım, Erkmén Giray

Yüksek Lisans, Ekonomi Bölümü

Tez Yöneticisi: Doç. Dr. Bilin Neyaptı

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Bu çalışmada sunulan teorik yaklaşım, mali yerelleşmenin, statik kapalı ekonomi modeli içerisinde, politik faktörleride göz önüne alarak, gelir ve refah etkilerini incelemek üzerinedir. İki alternatif senaryo sunulmaktadır; birinci senaryoda, hükümet sosyal planlamacı olarak davranır ve mali yerelleşme seviyesini optimal olarak çözer, diğer senaryoda ise hükümet politik yönelim göstermiştir ve vergi oranını belirler. Her iki senaryo altında da merkezi hükümetin yerel yönetimler ile etkileşimi sonucu, işbirliği gerçekleşmeyen sonuçlar elde edilmiştir. Modelin karşılaştırmalı statiklerine bağlı olarak çıkan açık sonuçlar, politika yorumlarına katkı sağlamıştır. Modeli daha iyi ve detaylı anlayabilmek için kalibrasyon ve simülasyon analizi yapılmıştır. Yardımsever hükümetlerin sosyal refah seviyesini, politik yaklaşan hükümetler ise, etkin vergi toplama esasına göre verimliliği geliştirdiği gözlenmiştir.

Anahtar Kelimeler: Mali Yerelleşme, Politik Ekonomi, Refah

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CHAPTER 1

INTRODUCTION

Fiscal decentralization and federalism have received more attention in the economics literature after the 1980s when the effectiveness of central government policies on decreasing poverty and stabilizing the economies were questioned. Oates' seminal study (1972) on centralized versus decentralized government systems contributed to the fiscal decentralization literature. One of the factors that fundamentally contributed to this recent trend of decentralization is the foundation of European Union (EU) which addresses the economic power allocation problem between the local governments and the EU.

Fiscal decentralization (fd) can be defined as a mechanism of shifting institutional power from central government to both market and local jurisdictions. In this study, power is defined as the cluster of fiscal responsibilities in that region with regard to the tax collection effort and spending. Decentralization Theorem of Oates (1972) postulates a system (centralized versus decentralized) where public good provision is Pareto-efficient; transfer of power from central government to local governments is argued to enhance public good provision in different regions.

In the literature we observe lots of studies considering the pros/cons of decentralization and centralization. Some theoretical studies use dynamic frameworks and some others consider static frameworks. The empirical and descriptive studies investigate the growth, corruption and budget deficit implications of fd in regard to tax competition, spillover effect and mobility. But they are generally inconclusive. Recent studies point out the role of structural and institutional factors in getting the welfare and efficiency results of fd. To my knowledge, in the studies using both frameworks, fd level is always considered as a exogenous variable. Moreover, theoretical modeling of political factors in fd models

is a recently developing area in the literature. Our approach is to endogenize the choice of fd in a static model with a political perspective.

In our study, social planner (SP) is a welfare enhancing institution (Pigouvian government). When the SP chooses fiscal decentralization (fd) level optimally, tax effort increases with the increase in share of public spending. Our formulation of the central government (CG) problem with the political proximities enables us to capture Leviathan features as well. Local governments (LG) maximize their own utility and determine the tax effort in each jurisdiction. We report the results of LG – SP and LG – CG interaction in two plausible scenarios. Explicit solutions of both interactions and the partial derivatives performed in the comparative statics analysis enable us to derive the policy implications.

Main motivation of this paper is to fill the gap in the literature by introducing a static political factor framework of fiscal decentralization model. The main contribution of this study to the fiscal decentralization literature is: we determine optimal fd level endogenously which enables us to show the changes in welfare and income distribution in response to the changes in fiscal variables and political proximity (p_i) of each jurisdiction to the CG. Main findings of our study are as follows. We show that

- i. If there is a benevolent SP in a closed economy, optimal fd increases in the share of private sector (α) and decreases in the public sector share (β).
- ii. When there is a benevolent SP, an increase in the share of public sector (β) leads to higher tax effort (a_i) and an increase in the private sector share (α) decreases the a_i in a closed economy.
- iii. t is negatively related with the relative share of the private sector and positively related with the relative share of the public sector.
- iv. When there is a Leviathan CG, an increase in the political proximity (p_i) leads to an increase in the tax rate (t).

- v. When there is a Leviathan CG, an increase in either political proximity (p_i) or fiscal decentralization level (fd) leads to a decrease in the tax effort (a_i).
- vi. When public good provision is higher in poor regions that are politically close to the CG, social welfare (USP) is improved compared to the provision of public goods to rich jurisdictions that are politically close to the CG.
- vii. When CG provide public goods to a poor jurisdiction that is politically close, social welfare (USP) is improved compared to CG being politically indifferent between poor and rich jurisdictions.
- viii. When CG provide public goods to a poor jurisdiction that is politically close, if fd level increases this will worsen social welfare (USP) and income distribution.
- ix. If CG is politically indifferent between jurisdictions, social welfare (USP) and income distribution improves as fd increases, in contrast to the case of CG being politically close to the poor jurisdiction.

The remainder of the paper is organized as follows. Chapter 2 presents a literature survey on fiscal decentralization. Chapter 3 introduces our model. Chapter 4 reports the solutions of our optimization problem in two scenarios. Chapter 5 performs the comparative statics analysis. Chapter 6 provides the calibration and simulation results. Chapter 7 concludes. Proofs and tables are relegated to the Appendix.

CHAPTER 2

LITERATURE SURVEY

Public sector plays an important role in regulating economy, affecting allocation, redistribution and responding to societal demands. Optimum welfare in a country requires justly distributed income and efficient use of resource in each jurisdiction. In this regard, comparing costs of providing public good by the central and local governments is fundamental in the fiscal decentralization literature. The analysis of the justifications for and the consequences of decentralization have captured great attention from both political scientists and the economists.

Many empirical and theoretical studies are conducted to show the determinants of fiscal decentralization. Arzaghi and Henderson (2005) construct a federalism index of 48 sample countries from 1960 to 1995. Their study underlines the fact that demographic factors have large and significant effects on determining the centralization level. They show that the level of fiscal decentralization depends on the constitutional structure of a country. In this regard, covariates of fiscal decentralization (i.e. income) may depend on the regime or the constitutional structure as well. However, in their limited sample size experiment, they reject the hypothesis that the economic and demographic effects differ by the constitutional structure (federal versus non-federal). They also show that decentralization increases with economic growth, population, and country size. They also argue that federalist system is highly correlated with democratization. However, in both centralization and decentralization cases, we observe government intervention to the market by means of its constitutional power.

Musgrave (1959) conceptualizes a free market where the government does not conduct any monetary and fiscal policies. In this set-up the public sector faces three problems; distribution, stability, and allocation. He concludes that even if there is a free market that operates at full employment with efficient resource allocation, public policies are needed to obtain optimal welfare. According to Keynes, instability occurs because 1) unregulated economies will not generate high and stable levels of output and employment; 2) excessive spending will generate inflation and inefficiency. In the absence of an effective government involvement, there may be inefficient use of resources among alternative goods and services; some activities may receive excessive support and others will have insufficient resource levels. Allocation problem is important as it also affects the redistribution of income.¹

Oates (1972) analyzes the importance of public sector in a different framework. He defines the fiscal federalism concept without the constitutional and political structures: the allocation of expenditure and revenue collection which is made across different administrative government levels. Wheare (1980) investigates decentralization from a political perspective and defines it as the division of powers between the government and sub-governments. In this study we combine these two perspectives and define politico-economic power as the mechanism that structures the interactions between central and local fiscal authorities in delivering socially and economically desired outcomes.

One of the key findings of Oates (1972) is that extreme cases such as unitary government and fully federalist government systems have more shortcomings than its benefits. However, federalism is thought to combine the strengths of a unitary government with those of decentralization. Aside from the constitutional power that may be given to local authorities, as economists we care about the public good and service provision. Federal system is highlighted as the optimal form of government because it facilitates the involvement of local decision makers. In contrast, a fully

¹ For example, we can consider the government spending on constructing a new public school. This is a shift in resource allocation from alternative uses to educational services. This shift will generate income redistribution towards construction activity and to individuals who receive the educational services.

centralized government system is unable to respond to different local preferences; some individuals may want less public goods and services resulting in a lower tax rate than others. Since analyzing the optimal level of fiscal decentralization is the basis of this study, it is important to address the extreme cases in the perspective of Oates (1972).

When compared to a fully centralized system, decentralized governments may have a greater capacity to maintain higher levels of output at lower prices. Although there is little consensus on this issue, Montinola, Qian and Weingast (1995) argue that China's successful economic growth is the result of economic reforms regarding federalism. However, in both cases there is a central agency that controls the money supply by avoiding rapid monetary expansion and high inflation rates due to the increase in fiscal spending. Oates (1972) argues that local governments are highly constrained in their capacity to stimulate the aggregate level of economic activity in their regions. Since there is high interdependence between some groups of localities, it is possible that contractionary policies or negative shocks affecting one jurisdiction will spill over neighbor jurisdictions. It is clear that cyclical movements in the aggregate economic activity can be only treated by countercyclical policies on a national scope. However, if each local jurisdiction conducts countercyclical policies differently, its positive effect will be dampened by mobility. In this regard, under an extremely decentralized system it is very difficult to adopt policies that distribute income equally in a region because there will be a high degree of mobility to jurisdictions which possess an income-tax program similar to the preferences of individuals.

Mobility is an important component of fiscal decentralization. Tiebout (1956) is the first to introduce a general equilibrium framework that yields a solution to the public good problem that best reflects the preferences of the individuals. He argues that a consumer (voter) has the incentive to select a community whose local government provides fiscal packages well suited for his preferences. If the number of communities are large and if there is high heterogeneity between communities then consumers will have a chance to fully realize their preferences by moving freely

across the communities. Tiebout (1956) argues that decentralized decision making enables optimal mixes of communities. However, Bewley (1981) criticize Tiebout models for neither reaching to equilibrium nor being Pareto-optimal under free mobility. Boadway (2001) also argues that the volume of mobility among regions is not sufficient enough to generate optimal communities under a competitive environment, even if high level mobility occurs. He states that zoning law in cities exist to show the unacceptable outcomes of unfettered mobility. In particular, zoning law restricts the usage and development of certain geographic areas such as industrial production or family residential.

On the other hand, Bloch and Zenginobuz (2011) introduce household mobility under Oates' (1972) framework and indicate that centralized system is efficient under high mobility and high spillovers. Their baseline model assumes that each local government simultaneously selects their tax rates in the first stage then in the second stage households' move. In this taxation game, jurisdictions are assumed to be symmetric; the effect of mobility on the equilibrium outcome is subject to this assumption. On the other hand, if two polar cases of pure public goods and local public goods are considered in each jurisdiction then they report that there is no significant effect of mobility on equilibrium values.

Even if there is no mobility across jurisdictions there may exist a free riding problem. Buchanan (1968) elaborates a two agent – two good (public and private goods) model to create a relation between public/private good consumption, production and trade under different productivity capacities where individuals can act strategically. The aim of the study is to attain equilibrium in which demand and supply of both private and public good is satisfied. However, strategic behavior may disturb the existing equilibrium even if there is no trade. If one individual recognizes the interdependence that the public good introduces then each individual will try to hold off production and try to leave the share of cost to the other individuals (i.e. the free-rider behavior).

An important benefit of decentralization is increased competition between local jurisdictions in regards to public good provision under internalized spillovers. If

one locality adopts effective techniques to serve their citizens, neighbor jurisdictions will try to adopt similar production and service techniques to avoid the criticism of local residents. Oates (1972) argues that increased competition will result in greater innovations in public good provision but his derivation is subject to the assumption of policy uniformity across jurisdictions.

Besley and Coate (2003) introduce spillover effects across regions through public good provision by defining a positive externality. They show that below a critical level of spillovers of public goods, fiscal decentralization dominates fiscal centralization in terms of social welfare. This result is shown with a static model in the absence of tax competition. However, Chu and Yang (2012) address the effects of both mobility and spillovers with a dynamic model where they consider tax competition. They compare the economic growth performance and social welfare of decentralized and centralized fiscal systems between two jurisdictions. They show that decentralization is more effective than centralization in terms of economic growth. Similar to other studies, they show that if the spillovers of public goods are above the critical level then centralization dominates decentralization. However, since higher capital mobility results in stronger tax competition, their findings imply that under an optimal degree of tax competition and below some critical level of spillovers of public goods, higher level of social welfare is achieved under a decentralized fiscal system. This result also shows that pursuing economic growth and simultaneously having social welfare may conflict with each other.

Chu and Yang (2012) argues that a Pigouvian government (i.e. a benevolent government), whose welfare consists of maximizing consumer utility, assumes away the potential role of tax competition in constraining the public sector. This may be the reason that fiscal centralization is more effective than fiscal decentralization in terms of social welfare. When there is no tax competition, Pigouvian welfare maximization is likely to lead the central government to internalize externalities, including corruption as a result of increased public good provision.

Epple and Nechyba (2004) analyze two cases where there are local tax and local expenditure spillovers under the assumption of homogenous households and a

Pigouvian system of local governments. They argue that when local Pigouvian governments inefficiently use the policy instruments then this generates an inter-jurisdictional spillover or local expenditure creating benefits or costs to other localities. They consider tax on capital. Under a closed economy this will raise inefficiencies by creating a distortion between the price paid to capital by firms and the price received by capital suppliers. In the absence of a tax competition, Pigouvian governments would analyze the efficiency costs of raising tax revenues in terms of the benefits of public good provision. On the other hand, inefficiently high use of tax in order to finance local public goods would generate over-provision of local goods under a welfare maximizing Pigouvian government system. Analogous to this result, inter-jurisdictional spillover of local public goods will result in lower spending in decentralized jurisdictions. This may explain why most studies using Pigouvian government models concludes that fiscal centralization dominates fiscal decentralization in terms of social welfare.

Wilson (1999) argues that tax competition studies show that wasteful competition for capital generates under provision of public goods through reduction in tax rates. However, Brennan and Buchanan (1980) defend that the power to tax does not directly imply the nature of spending. Rationalization for the government's power to tax and understanding of that power sharply distinguishes by itself. In particular, they argue that tax competition lowers the political abuse of taxation in Leviathan government systems.

Lockwood (2006) attempts to explain fiscal decentralization with a political economy perspective where it is in contrast to the traditional benevolent government systems which are making ad-hoc assumptions on policy uniformity to enhance efficient decentralization levels. He argues that political economy perspective has little to indicate on the costs of decentralization such as coordination failures of local governments.² He concludes that the consensus is weak on the benefits of fiscal decentralization. From the political economy viewpoint, fiscal decentralization is

² Coordination failures are generally due to externalities. Local governments fail to internalize the tax and expenditure externalities or they exploit economies of scale. (Oates, 1999)

thought to match the preferences of local consumers and it increases the accountability of governments where he assumes that policy-makers may not act towards the interest of the voters in a jurisdiction (i.e. rent seeking politicians). He also indicates that the allocation of powers between the central government and the regional governments are made by voting in the national legislature and by referendum. However, this procedure is different in federal and unitary states. In most federal states, the allocation of powers is attained by the constitutional amendment which requires the approval of the majority of regions.

Hatfield and Padró i Miquel (2012) consider a positive political economy theory of partial fiscal decentralization. They show that capital poor median voter would favor a partial degree of decentralization since; tax competition will lower the level of capital taxes that increases the capital flows to jurisdictions under a federalist system. In this regard, the median voter wants public good provision financed by capital tax revenues and redistributive public good provision is observed. This reveals the fact that it is socially efficient to obtain a partial fiscal decentralization system under capital mobility and optimal taxation. Governments can both match with the preferences of their citizens and achieve fiscal discipline. Analogous to this result, fiscal decentralization model of Akin, Cevik, and Neyapti (2011) offer a redistribution rule showing that under hard budget, fiscal decentralization results in higher fiscal discipline when local governments act strategically.³

However, under a federalist system with tax competition it is difficult to internalize externalities and this may result in higher budget deficits and under-provision of local public goods in a jurisdiction. Central government can have bailout policies to these districts. Crivelli and Staal (2013), argue that in such cases the size of localities matters.⁴ They conclude that there is a negative correlation between the size of a district and CG's willingness to provide bailouts. Spillover effects that are internalized by local governments are introduced under matching grants system of the central government to achieve efficient outcomes.

³ In this model tax collection effort is derived based on a specific transfer rule.

⁴ Size is defined as the population. Larger regions are more costly to bailout.

Another reason for the under-provision of local public goods is the political distance of central government to a district. There are political factors that can affect the transfer policy or public good provision of the central government. Oates (1998) mentions that political pressures are effective in central government transfer policies. These political pressures may force a central government to support a jurisdiction more or less, also affecting spillovers within jurisdictions.

Our study presents a model where the central government maximizes its objective function that takes into account its political proximity of localities, or alternatively the social planner maximizes welfare. Hence, the current study enables us to compare the two contrasting views of Pigouvian and Leviathan governments.

CHAPTER 3

MODEL

We analyze three agents of the economy in a static framework. Consider a closed economy where there are n local governments (LG), a central government (CG), and a social planner (SP). We introduce three agents in two different scenarios where in the first scenario (Scenario I) SP is assumed to be a benevolent government and its non-cooperative interaction with LG yields an optimal fiscal decentralization level (fd). SP's welfare maximization results are also consistent with the Pigouvian tradition. However, in the second scenario (Scenario II) CG behaves as a Leviathan government which maximizes its utility by considering its political proximity of each jurisdiction and LGs determine the tax collection effort (a_i) accordingly. Non-cooperative interaction between LG and CG yields an optimal tax level (t). In this set-up we can define the SP as the institutional mechanism which maximizes the social welfare. However, LG and CG maximize their own utility in terms of regional fiscal policies. For simplicity, we assume that there are only two jurisdictions ($i = 1, 2$) which can be considered as two neighbor districts. For the purpose of tractability, in each government's problem we use a Cobb-Douglas type of utility function in a log-linear form. There is no mobility and spillovers across jurisdictions. Section 3.1, 3.2 and 3.3 report each government's problem and their first order conditions. Interpretation of the optimal solutions is reported in the comparative statics chapter.

3.1 Local Government

Local government (LG) maximizes its utility which is composed of private consumption (C_i), local government spending (G_i^L), and the central government spending (G_i^C) in region i . G_i^L depends on the tax collection of LG in region i which is given by

$$G_i^L = fda_i t Y_i \quad (1)$$

where fd is the fiscal decentralization level, a_i is defined as the relative tax effort, t is the tax rate, and Y_i is the ex-ante total income in region i .

G_i^C depends on the distribution of tax revenues by the share of the weighted political proximity $\left(\frac{p_i}{\sum_{i=1}^n p_i} \right)$ where $0 \leq p_i \leq 1$. Since p_i shows the political closeness

of the CG then if $p_i=1$, CG's expenditures on locality i will be equal to the tax revenues collected by the central government. However, if $p_i > 1$ then the tax revenues are distributed between two jurisdictions ($i = 1, 2$) by the share of p_i . Political economy side of this study allows us to observe the changes in utility in terms of the political externalities faced by the jurisdictions.⁵

$$G_i^C = \left(\sum_{i=1}^n ((1-fd)tY_i) \right) \left(\frac{p_i}{\sum_{i=1}^n p_i} \right) \quad (2)$$

where $(1-fd)$ is the fiscal centralization level.

C_i depends on the disposable income (Y_i^D) of individuals. Y_i^D of households is the income available for consuming after the LG and CG collect their income tax revenues (T_i). Since $T_i = fda_i t Y_i + (1-fd)tY_i$ then Y_i^D and C_i equality yields:

$$C_i = Y_i - fda_i t Y_i - (1-fd)tY_i \quad (3)$$

The utility obtained from the i^{th} jurisdiction is defined as

$$U_i = \alpha \ln C_i + \beta \ln G_i^L + \beta \ln G_i^C \quad (4)$$

⁵ As we mentioned in the literature survey, political corruptions are studied in terms of the changes in the taxation power for each jurisdiction. Chu and Yang (2012) introduce rent seeking politicians and interpret the possible effects by the changes in lifetime utility of politicians.

where U_i is concave and increasing in C_i , G_i^L , and G_i^C .

$$\frac{\partial^2 U_i}{\partial C_i \partial G_i^L} \geq 0, \quad \frac{\partial^2 U_i}{\partial C_i \partial G_i^C} \geq 0, \quad \text{and} \quad \frac{\partial^2 U_i}{\partial G_i^L \partial G_i^C} \geq 0.$$

U_i satisfies Inada conditions as shown below.

$$\lim_{C_i \rightarrow \infty} \frac{\partial U_i}{\partial C_i} = 0, \quad \lim_{C_i \rightarrow 0} \frac{\partial U_i}{\partial C_i} = \infty, \quad \lim_{G_i^L \rightarrow \infty} \frac{\partial U_i}{\partial G_i^L} = 0, \quad \lim_{G_i^L \rightarrow 0} \frac{\partial U_i}{\partial G_i^L} = \infty, \quad \lim_{G_i^C \rightarrow \infty} \frac{\partial U_i}{\partial G_i^C} = 0, \quad \text{and} \\ \lim_{G_i^C \rightarrow 0} \frac{\partial U_i}{\partial G_i^C} = \infty.$$

Since the households are immobile, whether the LG chooses a local public good level or a tax effort is irrelevant.⁶ The utility maximization problem of the LG in jurisdiction i is thus given by

$$\begin{aligned} \max_{a_i} U_i &= \alpha \ln C_i + \beta \ln G_i^L + \beta \ln G_i^C \\ \text{subject to} & \quad (1), (2), \text{ and } (3) \end{aligned} \quad (5)$$

The solution of the LG's optimization problem can be written in terms of the tax effort (a_i)⁷:

$$a_i = \frac{\beta}{\alpha + \beta} \left(\frac{1}{fd} \frac{1}{t} - \frac{1}{fd} + 1 \right) \quad (6)$$

where α is the share of private consumption, ($0 < \alpha < 1$) and β is the share of government expenditures, ($0 < \beta < 1$).

⁶ "With mobile agents, the instrument chosen by jurisdictions becomes important. A jurisdiction i can either choose the tax rate and let the quantity of public good adjust according to the size of the jurisdiction, or fix the public good level and adapt the tax rate to cover the cost of public good." Bloch and Zenginobuz (2012), pg. 6

⁷ Please see the Appendix for the proof of the LG's problem.

3.2 Central Government

CG maximizes the total utility obtained from all jurisdictions. Utility gained from G_i^L is aggregated by the extent of political proximity (p_i).

Total utility obtained from each jurisdiction is defined as

$$\sum_{i=1}^n U_i = \alpha \sum_{i=1}^n \ln C_i + \beta \sum_{i=1}^n p_i \ln G_i^L + \beta \sum_{i=1}^n \ln G_i^C \quad (7)$$

If $p_i = 1$, CG is indifferent between the local and central spending. Hence, CG's optimization problem will yield the welfare maximizing institutional mechanism of a benevolent planner (SP).

CG optimally chooses the tax rate (t). In this model, fiscal decentralization level (fd) and political proximity (p_i) is taken as exogenous. The constraints denoted in LG's problem also apply in this set-up and the problem is reported as

$$\max_t \sum_{i=1}^n U_i = \alpha \sum_{i=1}^n \ln C_i + \beta \sum_{i=1}^n p_i \ln G_i^L + \beta \sum_{i=1}^n \ln G_i^C \quad (8)$$

subject to (1), (2), and (3)

where U_i is concave and increasing in C_i , G_i^L , and G_i^C . U_i also satisfies Inada conditions stated in the LG's problem.

The solution to the CG's problem is⁸

$$\alpha \sum_{i=1}^n \left(\frac{fd(1-a_i)-1}{1-tfda_i-(1-fd)t} \right) + \beta \left(\frac{\sum_{i=1}^n (p_i) + n}{t} \right) = 0 \quad (9)$$

⁸ Please see the Appendix for the proof of the CG's problem.

3.3 Social Planner

As an alternative to the CG's problem, SP is assumed to be a benevolent government who optimally chooses the level of fiscal decentralization (fd) by maximizing the overall social welfare $\left(\sum_{i=1}^n W_i \right)$. In this set-up, tax rate (t) is taken exogenously. Overall welfare in this model is positively related with the sum of C_i , G_i^L , and G_i^C .

The welfare function is denoted as

$$\sum_{i=1}^n W_i = \alpha \sum_{i=1}^n \ln C_i + \beta \sum_{i=1}^n \ln G_i^L + \beta \sum_{i=1}^n \ln G_i^C \quad (10)$$

Welfare maximization problem embodies the same constraints used in the LG's problem and it is given by

$$\max_{fd} \sum_{i=1}^n W_i = \alpha \sum_{i=1}^n \ln C_i + \beta \sum_{i=1}^n \ln G_i^L + \beta \sum_{i=1}^n \ln G_i^C \quad (11)$$

subject to (1), (2), and (3)

where W_i is concave and increasing in C_i , G_i^L , and G_i^C . W_i also satisfies Inada conditions stated in the LG's problem.

The first order condition to this problem is⁹

$$\alpha \left(\sum_{i=1}^n \frac{t(1-a_i)}{(1-tfda_i - (1-fd)t)} \right) + n\beta \left(\frac{1}{fd} - \frac{1}{(1-fd)} \right) = 0 \quad (12)$$

⁹ Please see the Appendix for the proof of the SP's problem.

CHAPTER 4

MODEL SOLUTIONS

4.1 SCENARIO I: LG – SP INTERACTION

In this scenario LG acts non-cooperatively with the SP; solving (6) and (12) simultaneously yields the optimal fiscal decentralization level (fd) and the corresponding tax effort (a_i) in the economy. Since SP is a benevolent institution, political effects are not binding in the choice of optimal fd. This scenario solves for the optimal fd as a function of the tax rate (t), private consumption and government expenditure share (α , β). Lemma 1 gives the optimal outcome of the non-cooperative interaction in two jurisdictions.¹⁰

Lemma 1. Under the LG-SP interaction, optimal fd and a_i for $i=1, 2$ is

$$fd = \frac{-\alpha + \beta t + 2\beta t}{(\alpha + 2\beta)t} \quad (13)$$

$$a_1 = a_2 = \frac{-\beta}{\beta - t(\alpha + 2\beta)} \quad (14)$$

where $0 < \alpha < 1$, $0 < \beta < 1$, $0 < t < 1$, $0 < fd < 1$, and $a_i > 0$.

¹⁰ Please see the Appendix for the proof of Lemma1.

4.2 SCENARIO II: LG – CG INTERACTION

This scenario evaluates the non-cooperative interaction of the LG with CG. Solving the first order conditions of both governments yields an optimal tax rate (t). Under this scenario we observe the effects of political proximity on relative tax effort (a_i) and the tax rate (t). If central government is politically close ($p_1 > p_2$) to one jurisdiction (i.e. $i = 1$) then we observe a lower tax effort in first locality and higher tax rate to equalize the utility from local public good provision. However, increase in the tax rate (t) in an economy will also lower the tax effort of the second locality. Hence, we observe that if $p_1 > p_2$ then tax effort is lower in all localities. Lemma 2 presents the optimal solutions of this simultaneous interaction.

Lemma 2. Under the LG-CG interaction, optimal t and a_i for $i=1, 2$ is

$$t = \frac{\beta p_1 + \beta p_2}{2\alpha + 2\beta - 2\alpha fd - 2\beta fd + \beta p_1 + \beta p_2 - \beta fd p_1 - \beta fd p_2} \quad (15)$$

$$a_1 = a_2 = \frac{-2(fd - 1)}{fd(p_1 + p_2)} \quad (16)$$

where $0 < \alpha < 1$, $0 < \beta < 1$, $0 < fd < 1$, $0 < p_i < 1$, $0 < t < 1$ and $a_i > 0$.

CHAPTER 5

COMPARATIVE STATICS

In this part of the study we perform a comparative static analysis to examine the policy implications of two fiscal schemes. In this regard, we are evaluating the partial derivatives of optimal fiscal decentralization level (fd), tax rate (t), and corresponding tax efforts (a_i) with respect to the model parameters: $\{fd, t, \alpha, \beta, p_1, p_2\}$ for both scenarios I and II. Section 5.1 presents the comparative statics for LG – SP optimal results and Section 5.2 reports the partial derivatives for LG – CG optimal solutions. In these sections we obtain unambiguous signs for each partial derivative. In the appendix, combined results for both scenarios are summarized (*Table 1*).

5.1 Comparative Statics for LG – SP Problem

The effects of the variables specified above are analyzed separately for fd and a_i . Subsections 5.1.1 and 5.1.2 report the partial derivatives for each case respectively.

5.1.1 Optimal Fiscal Decentralization Level

We will use the explicit fd solution (13) obtained in Scenario I:

$$fd = \frac{-\alpha + \beta t + 2\beta t}{(\alpha + 2\beta)t} \quad \text{for } i=1,2$$

whose partial derivative with respect to t is

$$\frac{\partial fd}{\partial t} = \frac{\beta}{t^2(\alpha + 2\beta)} > 0 \quad (17)$$

Since β, α and t are positive we observe that changes in the tax rate affect fiscal decentralization level positively. If the tax rate increases, utility derived from private sector will decrease. We observe that each locality decreases the tax effort so that the effective tax rate (τ_i) declines. However, SP is a benevolent government who wants to increase the welfare by choosing an optimal fd level. In this regard, SP increases fd to equalize the welfare.

The effect of private consumption share (α) in utility on fd is given by

$$\frac{\partial fd}{\partial \alpha} = \frac{\beta}{t(\alpha + 2\beta)^2} > 0 \quad (18)$$

Analogous to the case in (17) all exogenous in variables are positive therefore partial derivative is also positive. This result indicates that when the share of private consumption increases, utility gained from public provision of each jurisdiction increases. Therefore, SP increases the level of fd to transfer the fiscal power to localities.

The partial derivative of fd with respect to the utility weight of government spending (β) is

$$\frac{\partial fd}{\partial \beta} = \frac{-\alpha}{t(\alpha + 2\beta)^2} < 0 \quad (19)$$

All of the variables are positive but due to the negative sign on the numerator, the relationship between the government spending share (β) and fd is negative. This result is the opposite of (18). In this case, as the public sector share in the utility increases, households' loss of utility from tax collection to finance the public good can be compensated. Therefore, fiscal decentralization level decreases accordingly.

Proposition 1. If there is a benevolent SP in a closed economy, optimal fd increases in the share of private sector (α) and decreases in the public sector share (β).

5.1.2 Tax Effort

We will evaluate the optimal tax effort (14) obtain in Scenario I.

$$a_i = \frac{-\beta}{\beta - t(\alpha + 2\beta)} \quad \text{for } i = 1, 2$$

whose partial derivative with respect to t is

$$\frac{\partial a_i}{\partial t} = \frac{-\beta(\alpha + \beta)}{(\beta - t(\alpha + 2\beta))^2} < 0 \quad (20)$$

In this case, the denominator and the variables are positive but the numerator remains negative. Hence, the partial derivative is negative. If tax rate (t) increases, utility gained from private consumption decreases and localities decreases the tax effort (a_i) to maintain the same utility level.

The effect of private consumption share in utility (α) on tax effort (a_i) is

$$\frac{\partial a_i}{\partial \alpha} = \frac{-\beta t}{(\beta - t(\alpha + 2\beta))^2} < 0 \quad (21)$$

The partial derivative of a_i with respect to α is negative. Analogous to the analysis in (18), the increase in the share of private sector will result in higher public good provision by LG's. Hence, this is possible when exogenously determined tax rate (t) increases. From the result in (20), we know that if tax rate (t) increases, tax effort (a_i) will decrease.

The partial derivative of a_i with respect to β is

$$\frac{\partial a_i}{\partial \beta} = \frac{\alpha t}{(\alpha t + \beta(2t - 1))^2} > 0 \quad (22)$$

Since the denominator and exogenous variables are positive, the public sector share (β) is positively affected by the tax effort (a_i). This result is the opposite case of (21) which shows that when the share of public sector is higher, if there is a decrease in the tax rate (t) that increases private consumption then each jurisdiction increases their tax effort (a_i) to compensate the utility loss from LG's public good provision.

Proposition 2. When there is a benevolent SP, an increase in the share of public sector (β) leads to higher tax effort (a_i) and an increase in the private sector share (α) decreases the a_i in a closed economy.

5.2 Comparative Statics for LG – CG Problem

The effects of the model parameters on tax rate (t) and tax effort (a_i) are analyzed separately in the subsections 5.2.1 and 5.2.2.

5.2.1 Optimal Tax Rate

We will use the explicit t solution (15) obtained in Scenario II:

$$t = \frac{\beta p_1 + \beta p_2}{2\alpha + 2\beta - 2\alpha fd - 2\beta fd + \beta p_1 + \beta p_2 - \beta fd p_1 - \beta fd p_2} \quad \text{for } i = 1, 2$$

whose partial derivative with respect to fd is

$$\frac{\partial t}{\partial fd} = \frac{\beta(p_1 + p_2)}{(fd - 1)^2 (2\alpha + 2\beta + \beta p_1 + \beta p_2)} > 0 \quad (23)$$

Since all exogenous variables are positive and $(fd - 1)^2 > 0$ then the effect of fd on t is positive. If fd increases, CG's spending in utility decreases. CG increases the tax rate (t) to compensate the loss in utility.

The effect of private consumption share in utility (α) on t is given by

$$\frac{\partial t}{\partial \alpha} = \frac{\beta(2fd - 2)(p_1 + p_2)}{(2\alpha + 2\beta - 2\alpha fd - 2\beta fd + \beta p_1 + \beta p_2 - \beta fd p_1 - \beta fd p_2)^2} < 0 \quad (24)$$

In this partial derivative, we observe that $(2fd - 2) < 0$ because $0 < fd < 1$. Since the denominator is positive and the numerator is negative, α and t are negatively related. If the weight of private sector in utility (α) increases, CG may decrease the tax rate (t) to maintain higher utility from private consumption. In this regard, there is also a trade-off between private consumption and public good provision. Since a_i and t have a negative relationship, LGs may increase the tax effort (a_i) to compensate the utility loss coming from under-provision of public good.

Partial derivative of t with respect to β is

$$\frac{\partial t}{\partial \beta} = \frac{-2\alpha(p_1 + p_2)}{(2\alpha + (p_1 + p_2 + 2))^2 (fd - 1)} > 0 \quad (25)$$

Since $0 < fd < 1$, $(fd - 1)$ is negative the denominator is negative. Since the numerator is also negative, the result is positive: if β increases, the share of public sector spending in utility increases. Since a_i and t has a negative relationship, an increase in t also increases the utility obtained from CG's public good provision relative to G_i^L .

Since CG gains utility from LG's spending to the extent of its political proximity (p_i); an increase in the weight of government spending in utility (β) leads to an increase in the tax rate (t) and an increase in the private sector share in utility decreases the tax rate (t) in a closed economy .

Proposition 3. t is negatively related with the relative share of the private sector (α) and positively related with the relative share of the public sector (β).

The effect of p_i on t is reported as

$$\frac{\partial t}{\partial p_i} = \frac{-2\beta(\alpha + \beta)}{(2\alpha + 2\beta + \beta \sum_{i=1}^n p_i)^2 (fd - 1)} > 0 \quad \text{for } i = 1, 2 \quad (26)$$

Since $(fd - 1)$ is negative, the denominator is also negative. Moreover, the numerator is negative and yielding a positive relation between t and p_i . If p_i increases, utility gain from public good provision also increases. Hence, if CG increases the tax rate (t) this will yield a higher utility gain from G_i^C .

Proposition 4. When there is a Leviathan CG, an increase in the political proximity (p_i) leads to an increase in the tax rate (t).

5.2.2 Tax Effort

We will use the optimal a_i solution (16) obtained in Scenario II:

$$a_i = \frac{-2(fd - 1)}{fd \left(\sum_{i=1}^n p_i \right)} \quad \text{for } i = 1, 2$$

The partial derivative of a_i with respect to fd is

$$\frac{\partial a_i}{\partial fd} = \frac{-2}{fd^2 \left(\sum_{i=1}^n p_i \right)} < 0 \quad \text{for } i = 1, 2 \quad (27)$$

All exogenous variables are positive. Since the numerator is negative, the partial derivative is also negative. If fd increases, utility obtained from central government spending decreases and CG may increase the tax rate (t) to compensate the utility loss. However, this will lower private consumption (C_i). Therefore, LGs may lower their tax efforts (a_i) to equalize the loss in C_i .

The effect of political proximity (p_i) on a_i is given by

$$\frac{\partial a_i}{\partial p_i} = \frac{2fd - 2}{fd \left(\sum_{i=1}^n p_i \right)^2} < 0 \quad \text{for } i = 1, 2 \quad (28)$$

In this partial derivative, we observe that $(2fd - 2) < 0$ because $0 < fd < 1$. Hence, the effect of p_i on a_i is negative. In this case, if p_i increases, public sector spending increases and CG may increase the tax rate (t) to maximize the utility obtained from politically close jurisdiction. In this regard, both jurisdictions decrease their tax efforts (a_i) to compensate the utility loss in private consumption (C_i).

Proposition 5. When there is a Leviathan CG, an increase in either political proximity (p_i) or fiscal decentralization level (fd) leads to a decrease in the tax effort (a_i).

CHAPTER 6

CALIBRATION AND SIMULATION ANALYSIS

We obtained explicit signs for all partial derivatives of the optimal solutions. In order to get a better and deeper insight on the model, we also perform calibration and simulation analyze. Simulations and calibrations enable us to observe the changes in welfare (USP) and income distribution (Y_i^{Dist}) in response to different

fiscal decentralization (fd), political polarization $\left(\frac{p_1}{p_2}\right)$, ex-ante income (Y_i) and tax rate (t) levels. In this set-up, ex-post total income (Y_i^{P}) is endogenously determined

after CG chooses its spending in regard of the weighted political proximity $\left(\frac{p_i}{\sum_{i=1}^n p_i}\right)$.¹¹

Income distribution $\left(Y_i^{\text{Dist}} = \frac{Y_i^{\text{P}}}{Y_i}\right)$ shows the changes in income between Y_i^{P} and exogenously given Y_i .

Section 6.1 reports the calibrated model variables and parameters. The results of all calibrations are reported in Appendix. Section 6.2 reports the simulation analysis under the range of values assigned to the model parameters and exogenous variables. The values used in both sections satisfy all assumptions denoted in our model.

¹¹ In ex-post total income (Y_i^{P}) definition, we can observe the political effect coming from G_i^{C} . (i.e. $Y_i^{\text{P}} = C_i + G_i^{\text{L}} + G_i^{\text{C}}$)

6.1 Calibration Analysis

We analyze five cases for two scenarios in terms of the calibrated parameters and exogenous variables. First two cases (Case I, II) report the differences in social welfare (USP) and $Y_i\text{Dist}$ regarding the changes in ex-ante total income in region i (Y_i). Third case (Case III) is defined to compare Case II results under different political proximities. Case IV and Case V differ from the first two cases in regard to fd and t .

In Case I we define first region ($i = 1$) as rich ($Y_1 > Y_2$) but politically distant to the CG and second region ($i = 2$) is poor but politically close. In Case II, first region ($i = 1$) is poor and politically distant but second region ($i = 2$) is rich and politically close. If we compare Case I with Case II; for both cases, social welfare is higher and equalized for each locality in Scenario I because SP is a benevolent government who maximizes the welfare (USP) of each jurisdiction regardless of their political view. However, the income distribution ($Y_i\text{Dist}$) is better in Case I because changes in ex-post total income (Y_i^P) in Case I is higher than Case II. When we compare USP and $Y_i\text{Dist}$ changes in Scenario II for both cases; we observe that USP and $Y_i\text{Dist}$ are higher in first case. Since CG support poor region in first case, welfare and Y_i^P is improve much more than in the second case.

Proposition 6. When public good provision is higher in poor regions that are politically close to the CG, social welfare (USP) is improved compared to the provision of public goods to rich jurisdictions that are politically close to the CG.

If we analyze Case III, CG is indifferent between rich and poor jurisdictions in terms of political proximity. In this case, both scenarios report higher social welfare (USP) and income distribution ($Y_i\text{Dist}$) compared to Case II. However, Scenario I still dominates Scenario II in terms of USP and $Y_i\text{Dist}$. Among three cases,

the highest social welfare and income distribution for Scenario II is observed in Case I.

Proposition 7. When CG provide public goods to a poor jurisdiction that is politically close, social welfare (USP) is improved compared to CG being politically indifferent between poor and rich jurisdictions.

In Case IV, we analyze with different fd levels of Case I. Welfare and income distribution do not change in Scenario I. In Scenario II, increasing the fd level worsens welfare and income distribution.

Proposition 8. When CG provide public goods to a poor jurisdiction that is politically close, if fd level increases this will worsen social welfare (USP) and income distribution.

In Case V we analyze revised Case III with a different fd level where the CG is politically indifferent between jurisdictions. In both scenarios of Case V, an increase in fd level does not change the welfare and income distribution compared to Case III. However, if we compare Case IV with Case V; in both scenarios welfare and income distribution in Case V dominates Case IV.

Proposition 9. If CG is politically indifferent between jurisdictions, social welfare (USP) and income distribution improves as fd increases, in contrast to the case of CG being politically close to the poor jurisdiction.

6.2 Simulation Analysis

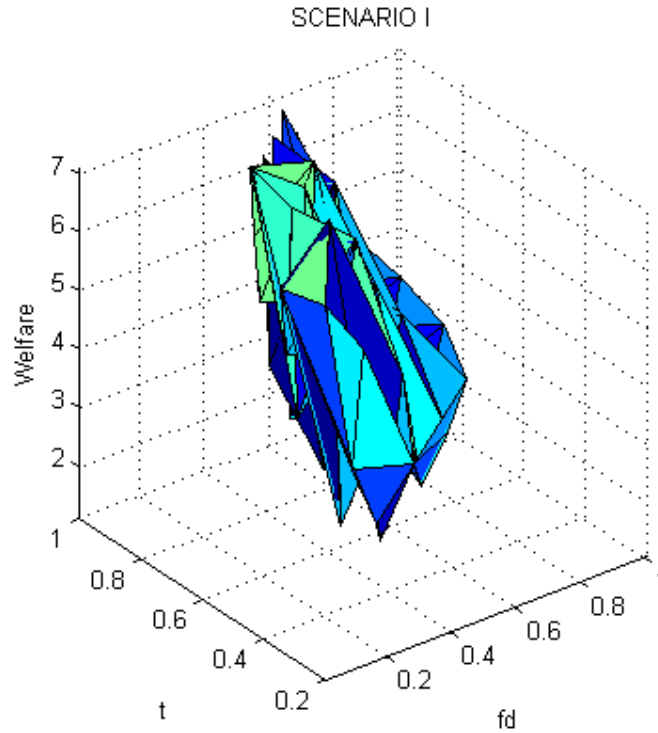
We perform a simulation analysis for Scenario I and Scenario II. We report the changes in welfare in response to the changes in fiscal decentralization level (fd) and tax rate (t) in both scenarios. The following are the range of values for model parameters

$$p_1 \in [0:1], p_2 \in [0:1], \alpha \in [0:1], \beta \in [0:1],$$

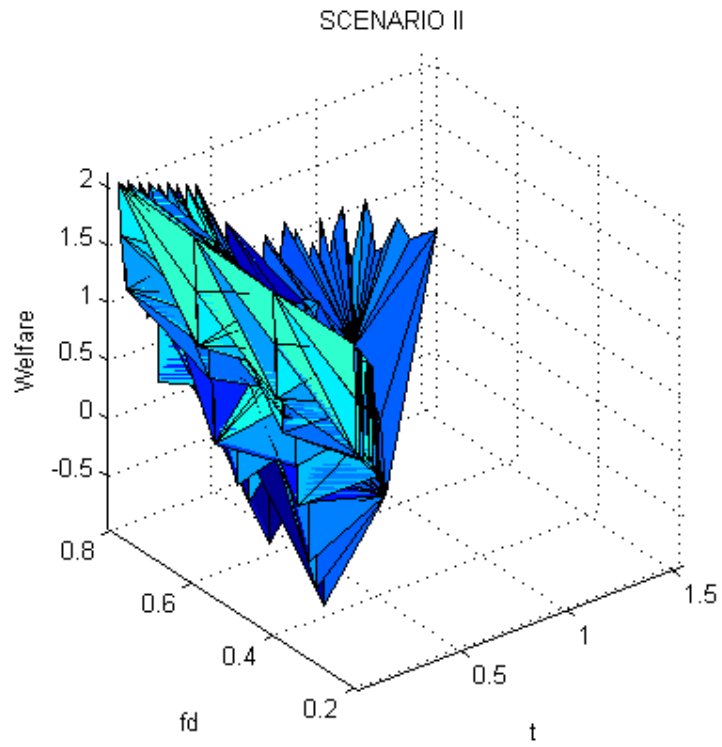
$$t \in [0:1]^*, fd \in [0:1]^{**}, x \in [0:5], Y_2 = 10$$

*: used only in Scenario I, **: used only in Scenario II

where $Y_1 = xY_2$.



For Scenario I; we can observe that when $0.6 < fd < 0.7$ and $t = 1$, social welfare attains its highest value.



For Scenario II; independent of fd level when lower than 0.4, if t is around 0.3, we report the highest social welfare.

CHAPTER 7

CONCLUSION

This study presents a theoretical approach to analyze the income and welfare implications of fiscal decentralization in response to the changes in fiscal variables and political proximity (p_i) of each jurisdiction to the central authority. Fiscal decentralization is defined as the politico-economic power which is a mechanism that structures the interactions between the central and local fiscal authorities in delivering socially and economically desired outcomes. In one of the scenarios, fiscal decentralization level is chosen optimally by the SP. Our model presents an alternative scenario where the central government chooses the tax level, given a level of fd .

All of the partial derivatives in our comparative statics analysis give explicit solutions which enable us to derive policy implications. In order to get a better and deeper insight on the model, we also perform calibration and simulation analysis. Main results of the proposed fiscal institutional design show that a benevolent government always enhances higher social welfare and income distribution levels compared to a Leviathan government system. Efficiency, measured by local tax collection efficiency, however, is greater under the Leviathan government. We also observe that given a fiscal decentralization level, political proximity is the key factor to analyze the changes in social welfare and income distribution between jurisdictions. We show that when CG provides public goods to a poor jurisdiction that is politically close, social welfare and income distribution improves compared to other cases.

Further modifications of the model will be made by introducing spillovers across jurisdictions and heterogenizing the tax efforts of each jurisdiction. Another remark on the potential extensions of this paper is: introducing a dynamic framework which shows the changes in economic growth in response to the changes in political

proximity. Nonetheless, we hope that our simple framework may serve well as a useful first approximation of determining fiscal decentralization level endogenously by the essence of political factors.

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APPENDIX

Index of Variables

C_i : Private consumption in region i , ($C_i > 0$).

G_i^L : Local government spending in region i , ($G_i^L > 0$).

G_i^C : Central government spending in region i , ($G_i^C > 0$).

Y_i : Ex-ante total income in region i , ($Y_i > 0$).

Y_i^P : Ex-post total income in region i , ($Y_i^P > 0$).

Y_i^D : Disposable income in region i , ($Y_i^D > 0$).

T_i : Income tax revenues collected by the LG and the CG in region i , ($T_i > 0$).

t : Tax rate determined optimally by CG, ($0 < t < 1$).

τ_i : Effective tax rate in region i , ($\tau_i < 1$).

a_i : Relative tax collection effort in region i , ($a_i > 0$).

p_i : Political proximity for region i , ($0 < p_i < 1$).

fd : Fiscal decentralization level which is chosen optimally by the SP, ($0 \leq fd \leq 1$).

W_i (USP): Welfare in region i , ($-\infty < W_i < +\infty$).

U_i (ULG, UCG): Utility obtained from region i , ($-\infty < U_i < +\infty$).

α : Utility weight of private consumption, ($0 < \alpha < 1$).

β : Utility weight of government expenditure, ($0 < \beta < 1$).

Y_iDist : Income distribution which shows the changes in $\frac{Y_i^P}{Y_i}$, ($Y_iDist > 0$).

Proof of LG's First Order Condition (FOC):

Substituting (1), (2), and (3) in (5) converts the problem into an unconstrained optimization as denoted below.

$$\max_{a_i} U_i = \alpha \ln(Y_i - fda_i t Y_i - (1-fd)t Y_i) + \beta \ln(fda_i t Y_i) + \beta \ln \left(\left(\sum_{i=1}^n ((1-fd)t Y_i) \right) \left(\frac{p_i}{\sum_{i=1}^n p_i} \right) \right)$$

$$\frac{\partial U_i}{\partial a_i} = \frac{\alpha(-fdt Y_i)}{Y_i - fda_i t Y_i - (1-fd)t Y_i} + \frac{\beta fdt Y_i}{fda_i t Y_i} = 0$$

$$a_i = \frac{\alpha}{\beta} \frac{Y_i - fda_i t Y_i - (1-fd)t Y_i}{fdt Y_i} = \frac{\alpha}{\beta} \left(\frac{1}{fdt} - a_i - \frac{1}{fd} + 1 \right)$$

$$a_i = \frac{\beta}{\alpha + \beta} \left(\frac{1}{fdt} - \frac{1}{fd} + 1 \right). \quad \square$$

Hence, for each jurisdiction ($i = 1, 2$) we have the same tax effort ($a_1 = a_2$).

Proof of CG's FOC:

Substituting (1), (2), and (3) in (6) yields an unconstrained optimization reported as

$$\max_t \sum_{i=1}^n U_i = \alpha \sum_{i=1}^n \ln(Y_i - fda_i t Y_i - (1-fd)t Y_i) + \beta \sum_{i=1}^n p_i \ln(fda_i t Y_i) + \beta \sum_{i=1}^n \ln \left(\left(\sum_{i=1}^n ((1-fd)t Y_i) \right) \left(\frac{p_i}{\sum_{i=1}^n p_i} \right) \right)$$

$$\frac{\partial \sum_{i=1}^n U_i}{\partial t} =$$

$$\alpha \sum_{i=1}^n \left(\frac{-fda_i Y_i - (1-fd)Y_i}{Y_i - fda_i t Y_i - (1-fd)t Y_i} \right) + \beta \sum_{i=1}^n p_i \left(\frac{fda_i Y_i}{fda_i t Y_i} \right) + \beta \sum_{i=1}^n \left(\frac{\left(\sum_{i=1}^n ((1-fd)Y_i) \right) \frac{p_i}{\sum_{i=1}^n p_i}}{\left(\sum_{i=1}^n ((1-fd)t Y_i) \right) \frac{p_i}{\sum_{i=1}^n p_i}} \right) = 0$$

$$\alpha \sum_{i=1}^n \left(\frac{fd(1-a_i)-1}{1-fda_i t - (1-fd)t} \right) + \beta \left(\frac{\sum_{i=1}^n p_i + n}{t} \right) = 0. \quad \square$$

If we have two jurisdictions then explicit solution is defined as

$$\alpha \left(\frac{fd(1-a_1)-1}{1-fda_1 t - (1-fd)t} + \frac{fd(1-a_2)-1}{1-fda_2 t - (1-fd)t} \right) + \beta \left(\frac{p_1 + p_2 + 2}{t} \right) = 0.$$

Proof of SP's FOC:

Substituting (1), (2), and (3) in (10) converts the model into an unconstrained optimization given by

$$\frac{\partial \sum_{i=1}^n W_i}{\partial fd} = \alpha \sum_{i=1}^n \left(\frac{-a_i t Y_i + t Y_i}{Y_i - f d a_i t Y_i - (1-fd)t Y_i} \right) + \beta \sum_{i=1}^n \left(\frac{a_i t Y_i}{f d a_i t Y_i} \right) + \beta \sum_{i=1}^n \left(\frac{\left(- \left(\sum_{i=1}^n (t Y_i) \right) \frac{p_i}{\sum_{i=1}^n p_i} \right)}{\left(\left(\sum_{i=1}^n ((1-fd)t Y_i) \right) \frac{p_i}{\sum_{i=1}^n p_i} \right)} \right) = 0$$

□

$$\alpha \sum_{i=1}^n \left(\frac{t(1-a_i)}{1-f d a_i t - (1-fd)t} \right) + n \beta \left(\frac{1}{fd} - \frac{1}{(1-fd)} \right) = 0.$$

We can simplify this explicit solution for two jurisdictions and it is reported as

$$\alpha \left(\frac{t(1-a_1)}{1-t f d a_1 - (1-fd)t} + \frac{t(1-a_2)}{1-t f d a_2 - (1-fd)t} \right) + 2 \beta \left(\frac{1}{fd} - \frac{1}{(1-fd)} \right) = 0.$$

Proof of Lemma 1:

Given two jurisdictions, substituting (6) in (12) yields

$$2\alpha \left(\frac{1 - \frac{\beta \left(1 - \frac{1}{fd} + \frac{1}{fdt} \right) t}{\alpha + \beta}}{1 - (1-fd)t - \frac{\beta f d \left(1 - \frac{1}{fd} + \frac{1}{fdt} \right) t}{\alpha + \beta}} \right) + 2\beta \left(-\frac{1}{1-fd} + \frac{1}{fd} \right) = 0$$

$$\beta \left(\frac{1-2fd}{-fd(fd-1)} \right) + \left(\frac{\alpha \left((\alpha + \beta)t - \beta \left(t - \frac{t}{fd} + \frac{1}{fd} \right) \right)}{(\alpha + \beta)(fdt - t + 1) - \beta(fdt - t + 1)} \right) =$$

$$\beta \left(\frac{1-2fd}{-fd(fd-1)} \right) + \left(\frac{(\alpha + \beta)t - \beta \left(t - \frac{t}{fd} + \frac{1}{fd} \right)}{t(fd-1)+1} \right) = 0$$

$$\frac{\beta(1-2fd)(t(fd-1)+1) - \left((\alpha + \beta)t - \beta \left(t - \frac{t}{fd} + \frac{1}{fd} \right) \right) fd(1-fd)}{-fdt(fd-1)^2 - fd(fd-1)} = 0$$

$$\frac{\beta t f d - \beta t - 2 f d^2 \beta t + 2 f d \beta t + \beta - 2 f d \beta}{-f d t (f d - 1)^2 - f d (f d - 1)} - \frac{(\alpha t f d^2 - \alpha t f d + \beta t f d^2 - \beta t f d - \beta t f d (f d - 1) + \beta t (f d - 1) - \beta (f d - 1))}{-f d t (f d - 1)^2 - f d (f d - 1)} = 0$$

$$\begin{aligned} & \frac{\beta t f d - \beta t - 2 f d^2 \beta t + 2 f d \beta t + \beta - 2 f d \beta - \alpha t f d^2 + \alpha t f d - \beta t f d^2}{-f d t (f d - 1)^2 - f d (f d - 1)} \\ & + \frac{\beta t f d - \beta t f d^2 - \beta t f d - \beta t f d + \beta t + \beta f d - \beta}{-f d t (f d - 1)^2 - f d (f d - 1)} = 0 \\ & \frac{-2 f d^2 \beta t + 2 f d \beta t - 2 f d \beta - \alpha t f d^2 + \alpha t f d + \beta f d}{-f d t (f d - 1)^2 - f d (f d - 1)} = \frac{2 f d \beta t - 2 f d \beta + \beta + \alpha t f d - \alpha t}{t (f d - 1)^2 + f d (f d - 1)} = 0 \end{aligned}$$

$$2 f d \beta t - 2 f d \beta + \beta + \alpha t f d - \alpha t = 0 \rightarrow f d = \frac{-b + \alpha t + 2 \beta t}{(\alpha + 2 \beta) t}. \quad \square$$

To obtain the corresponding optimal tax effort (a_i), we are substituting (13) in (6) and this is given by

$$a_i = \frac{\beta}{\alpha + \beta}$$

$$\left(\frac{1}{\left(\frac{-\beta + \alpha t + 2\beta t}{(\alpha + 2\beta)t} \right)^t} - \frac{1}{\frac{-\beta + \alpha t + 2\beta t}{(\alpha + 2\beta)t}} + 1 \right) = \frac{\beta}{\alpha + \beta} \left(\frac{\alpha + 2\beta}{-\beta + \alpha t + 2\beta t} - \frac{(\alpha + 2\beta)t}{-\beta + \alpha t + 2\beta t} + 1 \right)$$

$$a_i = \frac{\beta}{\alpha + \beta} \left(\frac{\alpha + 2\beta - \alpha t - 2\beta t - \beta + \alpha t + 2\beta t}{\beta - t(\alpha + 2\beta)} \right)$$

Since efforts are same for each locality, we will have

$$a_1 = a_2 = \frac{-\beta}{\beta - t(\alpha + 2\beta)}. \quad \square$$

Proof of Lemma 1:

Given two jurisdictions, substituting (6) in (9) yields

$$2\alpha \left(\frac{fd \left(1 - \frac{\beta}{\alpha + \beta} \left(\frac{1}{fdt} - \frac{1}{fd} + 1 \right) \right) - 1}{1 - tfd \frac{\beta}{\alpha + \beta} \left(\frac{1}{fdt} - \frac{1}{fd} + 1 \right) - (1 - fd)} \right) + \beta \left(\frac{p_1 + p_2 + 2}{t} \right) = 0$$

$$2\alpha \left(\frac{fd - \frac{\beta}{\alpha + \beta} \left(\frac{1}{t} - 1 + fd \right) - 1}{1 - \frac{\beta}{\alpha + \beta} (1 - t + tfd) - (1 - fd)t} \right) + \beta \left(\frac{p_1 + p_2 + 2}{t} \right) = 0$$

$$2\alpha \left(fd - \frac{\beta}{\alpha + \beta} \left(\frac{1}{t} - 1 + fd \right) - 1 \right) + \beta(p_1 + p_2 + 2) \left(1 - \frac{\beta}{\alpha + \beta} (1 - t + tfd) - (1 - fd)t \right) = 0$$

$$2\alpha \left(fdt - \frac{\beta}{\alpha + \beta} + \frac{\beta}{\alpha + \beta} t - \frac{\beta}{\alpha + \beta} fdt - t \right) +$$

$$\beta(p_1 + p_2 + 2) \left(\frac{\alpha}{\alpha + \beta} + t \left(-\frac{\beta}{\alpha + \beta} (fd - 1) + (fd - 1) \right) \right) = 0$$

$$2\alpha \left(t \left(fd \frac{\alpha}{\alpha + \beta} - \frac{\alpha}{\alpha + \beta} \right) - \frac{\beta}{\alpha + \beta} \right) + \beta(p_1 + p_2 + 2) \frac{\alpha}{\alpha + \beta} (1 + t(fd - 1)) = 0$$

$$\text{Let RHS} = \beta(p_1 + p_2 + 2) \frac{\alpha}{\alpha + \beta} (1 + t(fd - 1))$$

$$\text{RHS} = \frac{\alpha\beta}{\alpha + \beta} p_1 + t \frac{\alpha\beta}{\alpha + \beta} p_1 (fd - 1) + \frac{\alpha\beta}{\alpha + \beta} p_2 + t \frac{\alpha\beta}{\alpha + \beta} p_2 (fd - 1) + \frac{2\alpha\beta}{\alpha + \beta} + t \frac{2\alpha\beta}{\alpha + \beta} (fd - 1)$$

$$\text{RHS} = t \frac{\alpha\beta}{\alpha + \beta} ((fd - 1)(p_1 + p_2 + 2)) + \frac{\alpha\beta}{\alpha + \beta} (p_1 + p_2 + 2)$$

$$\text{Let LHS} = 2\alpha \left(t \left(fd \frac{\alpha}{\alpha + \beta} - \frac{\alpha}{\alpha + \beta} \right) - \frac{\beta}{\alpha + \beta} \right) = t \left(fd \frac{2\alpha^2}{\alpha + \beta} - \frac{\alpha}{\alpha + \beta} \right) - \frac{2\alpha\beta}{\alpha + \beta}$$

When we evaluate $\text{LHS} + \text{RHS} = 0$, all of the $(\alpha + \beta)$'s cancel out and it is reported under the common parenthesis of the tax rate (t) as

$$t(2fd\alpha^2 - 2\alpha^2\beta + \alpha\beta(fd - 1)(p_1 + p_2 + 2)) + \alpha\beta(p_1 + p_2 + 2) - 2\alpha\beta = 0$$

$$t(2\alpha fd - 2\alpha + \beta(fd - 1)(p_1 + p_2 + 2)) + \beta p_1 + \beta p_2 = 0$$

$$t(2\alpha fd + \beta p_1 fd + \beta p_2 fd + 2\beta fd - 2\alpha - \beta p_1 - \beta p_2 - 2\beta) = -(\beta p_1 + \beta p_2)$$

$$t = \frac{\beta p_1 + \beta p_2}{2\alpha + 2\beta - 2\alpha fd - 2\beta fd + \beta p_1 + \beta p_2 - \beta fd p_1 - \beta fd p_2}. \quad \square$$

Substituting (9) in (6) gives the corresponding tax effort (a_i) in two jurisdictions

$$a_i = \frac{\beta}{\alpha + \beta} \left(\frac{2\alpha + 2\beta - 2\alpha fd - 2\beta fd + \beta p_1 + \beta p_2 - \beta fd p_1 - \beta fd p_2 - \beta p_1 - \beta p_2 + \beta fd p_1 + \beta fd p_2}{fd(\beta p_1 + \beta p_2)} \right)$$

Since efforts are same for each jurisdiction, we will have

$$a_1 = a_2 = \frac{1}{\alpha + \beta} \frac{2\alpha(1 - fd) + 2\beta(1 - fd)}{fd(p_1 + p_2)} = \frac{-2(fd - 1)}{fd(p_1 + p_2)}. \quad \square$$

Comparative Statics Table, (Table 1):

If a derivative of a variable does not exist then it is denoted with dots (..) in the table reported below. $\frac{\partial a_i}{\partial t}$ denoted in the LG – CG problem is obtained from (6).

Similarly, $\frac{\partial a_i}{\partial fd}$ denoted in the LG – SP problem is also obtained from (6).

	Partial derivatives with respect to:					
	<i>fd</i>	<i>t</i>	<i>a</i>	<i>b</i>	<i>p1</i>	<i>p2</i>
LG - CG Problem:						
∂t	+	..	-	+	+	+
∂a_i	-	-	..	..	-	-
LG - SP Problem:						
∂fd	..	+	+	-	..	..
∂a_i	-	-	-	+	..	..

CALIBRATION TABLES

TABLE 2

	CASE I		CASE II		CASE III	
α	0,7		0,7		0,7	
β	0,3		0,3		0,3	
p_1	0,2		0,2		0,5	
p_2	0,7		0,7		0,5	
Y_1	20		10		10	
Y_2	10		20		20	
	Scenario:		Scenario:		Scenario:	
	I	II	I	II	I	II
fd	0,50	0,50	0,50	0,50	0,50	0,50
t	0,46	0,24	0,46	0,24	0,46	0,26
a_i	1,01	2,22	1,01	2,22	1,01	2,00
C_1	10,77	12,33	5,38	6,17	5,38	6,09
C_2	5,38	6,17	10,77	12,33	10,77	12,17
G_1^L	4,62	5,29	2,31	2,64	2,38	2,61
G_2^L	2,31	2,64	4,62	5,29	4,62	5,22
G_1^C	1,54	0,79	1,54	0,79	3,46	1,96
G_2^C	5,38	2,78	5,38	2,78	3,46	1,96
UCG	3,74	3,57	3,85	3,53	3,94	4,20
ULG	2,25	2,19	1,56	1,50	1,80	1,75
USP	4,19	4,06	4,19	3,42	4,30	3,81
Y_{1post}	16,92	18,41	9,23	9,60	11,15	10,65
Y_{2post}	13,08	11,59	20,77	20,40	18,85	19,35
$YDist(post/pre)$	0,65	0,79	1,12	1,06	0,84	0,91

TABLE 3

	CASE IV		CASE V	
α	0,7		0,7	
β	0,3		0,3	
p_1	0,2		0,5	
p_2	0,7		0,5	
Y_1	20		10	
Y_2	10		20	
	Scenario:		Scenario:	
	I	II	I	II
fd	0,70	0,70	0,70	0,70
t	0,77	0,40	0,77	0,43
a_i	0,43	0,96	0,43	0,86
C_1	10,77	12,33	5,38	6,09
C_2	5,38	6,17	10,77	12,17
G_1^L	4,62	5,29	2,31	2,61
G_2^L	2,31	2,64	4,62	5,22
G_1^C	1,54	0,79	3,46	1,96
G_2^C	5,38	2,78	3,46	1,96
UCG	3,74	3,57	3,94	4,20
ULG	2,25	2,19	1,80	1,75
USP	4,19	3,57	4,30	3,81
Y_{1post}	16,92	18,41	11,15	10,65
Y_{2post}	13,08	11,59	18,85	19,35
$YDist(post/pre)$	1,55	1,27	0,84	0,91