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Fiscal Decentralization and Public Sector Employment: A Cross-Country Analysis

Ming-Hung Yao

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FISCAL DECENTRALIZATION AND PUBLIC SECTOR EMPLOYMENT:

A CROSS-COUNTRY ANALYSIS

BY

MING-HUNG YAO

A Dissertation Submitted in Partial Fulfillment
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ACCEPTANCE

This dissertation was prepared under the direction of the candidate's Dissertation Committee. It has been approved and accepted by all members of that committee, and it has been accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Economics in the Andrew Young School of Policy Studies of Georgia State University.

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ABSTRACT

FISCAL DECENTRALIZATION AND PUBLIC SECTOR EMPLOYMENT: A CROSS-COUNTRY ANALYSIS

BY

MING-HUNG YAO

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This dissertation seeks to investigate the relationship between public sector employment and fiscal decentralization. We develop a theoretical model that helps us understand the interaction of the central executive's and subnational governor's decisions on the level of public employees at the central and subnational levels. Our empirical work shows that fiscal decentralization policy shifts central government employees to the subnational government level and that the increase in public employees at the subnational government level overwhelms the decrease in public employees at the central level. As a result, the level of total public sector employees increases with the degree of fiscal decentralization of a country. We also find that the levels of total public sector employees as a percentage of population are higher in unitary country systems than those in federal

countries. The level of public employment also increases with the degree of urbanization and with the exposure to risk of a country.

This is somewhat a surprising result. Typically, more public employment is associated with an excessive number of public sector employees, and, therefore, with unproductive spending. On the other hand, fiscal decentralization policy has been generally thought to result in an increase in allocative efficiency, since a decision on public expenditures made by a level of government that is closer and more responsive to a local constituency is more likely to reflect the demand for local services than a decision made by a remote central government. In addition, decentralization has been thought as having the potential of improving competition among governments and of facilitating technical innovations. Therefore, one might expect that fiscal decentralization should help to retrench the public sector employment. However, from our empirical result, we find that subnational governors without taking full responsibility for subnational public finance tends to bloat the levels of subnational government employees and ask the central government to pay the bill. As a result, the level of total public sector employees increases with fiscal decentralization policy. These findings are much in line with Oates' and Wallis' anticipated results, but they are based on different explanations.

Employing the two most commonly used spatial dependency tests, Moran's *I* and Getis and Ord's *G* statistics, we also find evidence of spatial dependency in terms of the level of public sector employees as a percentage of population among the countries in our dataset. This finding suggests that while using country's own domestic variables to explain the level of public sector employment, we should not ignore that the neighboring countries' policies also play an important role in determining it.

CHAPTER ONE: INTRODUCTION

There is little doubt that the government activities play an important role in the modern economy. Government influences the economy via several instruments, such as fiscal policies and monetary policies. Public sector employment, which accounts for a considerable share of total employment in many economies, is an important tool of fiscal policy and has attracted a great deal of attention over the past two decades (Gregory & Borland, 1999). Today bloated bureaucracies and over-staffed public enterprises are very common problems in developing countries, especially in transition economies, where the shift from plan to market requires millions of workers to be relocated. An excessive number of ministries, duplications of functions, or the existence of ghost workers has been identified as major instances of unproductive spending (Rama, 1997). Consequently, retrenchment of public sector employment is becoming an important issue of economic reform in these countries.

Decentralization, defined as the transfer of authority and responsibility for public functions from the central government to subordinate or autonomous government (subnational government hereafter) organizations or the private sector, has been a worldwide trend in the last two decades (Rondinelli, 1999).[1] An economic argument for decentralization is that it increases allocative efficiency. First, a decision about public expenditures that is made by a level of government that is closer and more responsive to a local constituency is more likely to reflect the demand for local services than the one that is made by a remote central government. Second, decentralization leads to competition among governments and enhances innovations (Ford, 1999). Due to these two arguments

[1] For more detail of the definition of decentralization, please refer to Chapter Four.

for decentralization, one might suggest that fiscal decentralization may be a remedy for bloated bureaucracies and over-staffed public enterprise in developing countries. In this dissertation we try to answer whether the fiscal decentralization policy would help to retrench the public sector employment.

In Appendix A, we show the cross-county public sector employment data as a percentage of population from 1985 to 2005 for Organization for Economic Co-operation and Development (OECD hereafter) and non-OECD countries.[2] From those data, we can observe several trends. First, while public sector employment has grown in some countries, it has shrunk in the others for the period 1985-2005. We can call this the time series variation of public employment. Second, the size of public sector employment in some countries is larger than that in other countries in any year. We can call this the cross-sectional variation of public employment. This dissertation seeks to explain these variations over time and across countries in public sector employment. Besides gaining an understanding of the sources of public employment variation over time and across countries, we are also interested in examining the process of public employment decentralization in some countries around the world and the degree of public employment decentralization in some countries growing faster than the others. We can call this the structural dimension variation in public employment. Appendix B shows the public employment as a percentage of population at the central and subnational government

[2] These data are from the *International Labor Organization Public Sector Dataset*, published by the International Labor Organization (ILO) bureau of statistics. The website is http://laborsta.ilo.org/, accessed June 11, 2007. The data are available since 1985. Before 1996, the data are available every five years. Since then the data are available every year. The latest year data available are 2004. In order to compare the data after 1995 to those before 1996, we calculate the five year average for the year 2000 and 2005. That is, the observations of year 2000 and 2005 are the unweighted average from year 1996 to 2000 and from 2001 to 2004 respectively. The list of OECD member countries can be found at OECD web page at: http://www.oecd.org/document/58/0,2340,en_2649_201185_1889402_1_1_1_1,00.html, accessed June 11, 2007.

levels for OECD and selected non-OECD countries in 1995 and 2000.[3]

Three hypotheses have been used to explain these variations in public employment. The first is a conventional economic explanation and it is known as Wagner's law. This "law" argues that economic development creates demand for new types of government services (Kraay & van Rijckeghem, 1995; Rama, 1997; Schiavo-Campo *et al.*, 1997a, 1997b; Tait & Heller, 1984). The second is a political-economy explanation which views public employment as a means by which politicians conceal redistribution in favor of specific groups (Alesina *et al.*, 2000; Alesina *et al.*, 2001; Gelb *et al.*, 1991; Gimpelson & Treisman, 2002; Robinson & Verdier, 2002). The third is an international economic explanation, according to which public employment is linked with the exposure to foreign trade of a country (Rama, 1997; Rodrik, 1996, 1997).

Although all these three hypotheses may seem to explain part of the variation in public employment, they do not seem to account for all the relevant facts. If Wagner's law is correct, one would expect richer countries or richer subnational regions to have higher level of public employees. However, for example, in Italy we find that the poorer regions have higher level of public employees than the richer regions (Alesina *et al.*, 2001). If public employment is a tool for politicians to transfer benefits to specific groups, one should expect countries or subnational regions with the same population to have the same amount of such patronage flows. Is this the case? In reality, such benefits correlate with the degree of ethnic division or income inequality but not the amount of population (Alesina *et al.*, 2000). Finally, if setting up a higher level of public employees is an

[3] This data are from the *World Bank Public Sector Employment & Wage Dataset*, which is published by the World Bank. The website is http://sima-ext.worldbank.org/publicsector/, accessed June 11, 2007. In this dissertation the terminology of subnational government is referring to the summation of state (or province in some countries) and local governments.

instrument for officials to conciliate the impact of trade-related dislocation, why do they choose such as an inefficient tool (Robinson & Verdier, 2002)? Retraining or transfer schemes would be far more cost-effective policy, whether the politicians' goal is to insure vulnerable workers or to buy votes (Gimpelson & Treisman, 2002).

While these three hypotheses might work well in explaining some facts about public employment levels over time and across countries, none of these hypotheses appears to provide a clear rationale for the structural dimension, that is, a relative change of public employment at the subnational government level compared to that at the central government level. Decentralization helps us to explain the change of the structural dimension of public sector employment. With fiscal decentralization policy, the central government transfers some responsibilities to the subnational governments. As a result, we expect that the level of public sector employees at the central government level decreases and that at the subnational government level increases with the degree of fiscal decentralization. The overall impact of fiscal decentralization on total public sector employment depends on these two opposing effects. If the magnitude of the reduction in the central government employment overwhelms the increase in the subnational government employment, then total public sector employment shrinks with the degree of fiscal decentralization. In other words, the fiscal decentralization policy helps to retrench the public sector employment. On the other hand, if the magnitude of the increase in the subnational government employment overwhelms the reduction in the central government employment, then total public sector employment grows with fiscal decentralization. Both cases are supported by some hypotheses as we will discuss in Chapter Two. Moreover, we also want to see what factors might affect the magnitudes of

these two effects.

While using the relative change of public employment at the subnational government level compared to that at the central government level to explain the variation in public employment across countries, we should not ignore the potential role played by "spatial effects," that is policy makers may be affected by their "neighbors" when they design their fiscal policy. The first explanation for the existence of spatial effects is that there exists externalities across countries and, therefore, fiscal policy choices are interactive. A second explanation is that citizens can evaluate the performances of their policy makers by comparing the same policy choices taken by the neighboring countries (Redoano, 2003).[4] Given the relevance of these two explanations, we will test for the presence of spatial effects as a determinant of the level of one country's public sector employment.

Public sector employment is different from private sector employment in that the decision-making on public sector employment and wage determination occurs in a political environment, whereas private sector decision-making takes place in a market environment (Ehrenberg & Schwarz, 1986; Gregory & Borland, 1999). Politician or bureaucrats might have goals that are different from those of the owners of private sector firms. Due to such differences, we could understand public sector employment only by considering the public labor market as a separate entity.

In this dissertation, we develop a theoretical model of public employment in an attempt to offer a different hypothesis that has the potential of explaining the structural variation in public employment and perhaps the time-series and cross-sectional variations in public employment. In the empirical chapter of the dissertation, we use two separate

[4] The second explanation is known as yardstick competition, initially explored by Besley and Case (1995).

datasets to test the hypotheses derived from our theoretical model. The main goal of this dissertation is to analyze the role of fiscal decentralization policy on public sector employment. Furthermore, we want to find out the determinants of public employment at the central and subnational government levels and to the aggregate level as well. Besides, we also want to detect whether there exists evidence of spatial effects in determining the level of one country's public sector employment. This dissertation consists of five chapters. In the current chapter, we motivate the main topic of this research. In Chapter Two, we review and summarize previous research on public sector employment and its relationship with fiscal decentralization. In Chapter Three, we develop a theoretical model to analyze the relationship between the degree of fiscal decentralization and public sector employment level. In Chapter Four, we describe the dataset we use in this study and present the empirical results based on the data we have. Chapter Five offers the conclusion.

CHAPTER TWO: LITERATURE REVIEW

In this chapter, we review previous studies on public sector employment, and then we discuss why fiscal decentralization might play an important role in the determination of public sector employment. In the first section of this chapter, we discuss several hypotheses, as suggested by previous studies, which can help to explain the difference of public sector employment among regions within a country and across countries. In the second section, we discuss why fiscal decentralization policy might influence public sector employment. In the third section, we review literatures of fiscal policy interaction across countries, while our focus is on the expenditure side.

Three Hypotheses on Public Employment

In this section, we discuss three hypotheses that seek to explain the difference in public sector employment across countries. The first hypothesis is Wagner's law. It argues that economic development creates demand for new types of government service. The second hypothesis is the rent-seeking hypothesis, as first suggested by Gelb *et al.* (1991). This hypothesis argues that public employment is viewed as a means by politicians to conceal redistribution in favor of specific groups. The third hypothesis is the social insurance hypothesis, as suggested by Rodrik (1996). This hypothesis argues that public employment could be used to buffer the population against external risk. We review these three hypotheses in turn and then report on empirical studies that have found support for each of these hypotheses.

Wagner's Law

First, Wagner's law argues that economic development creates demand for new types of government services. In other words, government services rise at a faster rate than economic development. Economic development clearly correlates cross-nationally with larger public sectors. Empirically, the size of public sector is measured in terms of either the share of government expenditure to gross domestic product (GDP hereafter) or the share of government employees to population. The size of public sector has been generally measured through government expenditures, but the determinants of public sector employment have only been discussed in a few studies, namely those by Tait and Heller (1984), Kraay and van Rijckeghem (1995), Schiavo-Campo *et al.* (1997b), Rama (1997), Rodrik (1996; 1997) , Alesina *et al*. (2000), Alesina *et al*. (2001), Gimpelson and Treisman (2002) and Marques-Sevillano and Rossello-Villallonga (2004). These studies vary in their country coverage as well as in their methodology. Some of these studies are concentrated on a particular country, such as the case study on the United States of Alesina *et al*. (2000), the case study on Italy of Alesina *et al*. (2001), the case study on Russia of Gimpelson and Treisman (2002) and the case study on Spain of Marques-Sevillano and Rossello-Villallonga (2004). The others are cross country studies.

Most cross country studies confirm, or conditionally confirm Wagner's law, such as in Tait and Heller (1984), Kraay and van Rijckeghem (1995), Schiavo-Campo *et al.* (1997b) and Rama (1997). Tait and Heller (1984) use a cross country dataset of 61 countries for 1980 to investigate whether there are any common factors explaining the size of public sector employment.[5] Their main result is that government employees per

[5] If the data is not available for that year, they use the closest available year data.

capita tends to increase as per capita income rises, thus supporting the validity of the alternative test of Wagner's law. Kraay and van Rijckeghem (1995) use a panel dataset of 34 developing countries and 21 OECD countries from 1972 to 1992 to examine the determinants of public sector employment and wages based on an efficiency wage model. They find that government employment is positively associated with the resource constraint, which is the revenue-to-GDP ratio in the case of developing countries and GDP per capita in the case of OECD countries. Schiavo-Campo *et al.* (1997b) developed a cross country dataset on central and subnational government employment and wage statistics for almost 100 countries in the early 1990s, both advanced and less developed countries.[6] For the entire sample, they find that the level of government employees is positively correlated with per capita income and thus confirm Wagner's law. However, for the sample of OECD countries, this association is not statistically significant, which indicates that Wagner's law may become inoperative beyond a certain level of development. Rama (1997) uses an unbalanced panel dataset of general government employment covering 90 countries for the 1970s, the 1980s, and the 1990s.[7] He finds that at low levels of economic development, general government employment increases with output per capita, as predicted by Wagner's law. However, the relationship is not monotonic but quadratic, with the turning point at around 14,000 dollars per capita, at 1985 PPP prices.

From the empirical results of these cross country studies, we find that Wagner's law is confirmed, or conditionally confirmed. The interesting finding is that the public

[6] The dataset has been updated. One more period, the year of 2000, has been added in the dataset. The dataset is available at http://sima-ext.worldbank.org/publicsector/, accessed June 6, 2007. Please refer to Footnote 3 and Appendix B.

[7] In his empirical study, Rama (1997) measures the size of public sector as the share of general government employees to labor force, instead of population.

sector employment grows with economic development but the relationship is not monotonic. Beyond a certain level of development, this relationship becomes insignificant and Wagner's law becomes inoperative.

Rent-Seeking Hypothesis

Wagner's law works well in explaining the levels of public employees across countries but not always so well within them. For example, Alesina *et al.* (2001) find that the number of public employees in the poorer regions (the South) in Italy is significantly larger than that in richer regions (the North). Therefore, we suspect that there would appear to be some factors other than economic development influencing the level of public employment within a country. Now, we turn our focus on the rent-seeking hypothesis, as suggested by Gelb *et al.* (1991). They develop a theoretical model to argue that governments in developing countries should, and do, provide valuable goods and services which generate a derived demand for factors of production. However, the public sector differs from the private sector in the extent to which the public sector is subject to political pressures for employment. Rent seeking and rent creating behavior can give rise to a wasteful diversion of resources into the public sector over and above the derived demand for resources. Robinson and Verdier (2002) explain why public sector employment is politically attractive, even that it might be socially highly inefficient. They argue that this is because public sector employment is a good commitment device between politicians and voters. From their theoretical model, they find that inefficient redistribution and clientelism become a relatively attractive political strategy in situations with high inequality and low productivity. Neither of these two studies provides empirical

evidence. Next we review some empirical studies that find support for this hypothesis.

Along the same lines, Alesina *et al.* (2000) argue that politicians may use disguised redistributive policies, such as public employment, in order to circumvent political opposition to explicit tax-transfer schemes. Their empirical results are consistent with the prediction of the hypothesis in that in the United States cities politicians appear to use public employment as a redistributive device. They find that the city level of public employees in the United States is significantly higher in cities where income inequality and ethnic fragmentation are higher.

Alesina *et al.* (2001) examine the regional distribution of public employment in Italy. They explain why the number of public employees in the poorer regions (the South) in Italy is significantly larger than that in the richer regions (the North). They compute the amount of expenditure on public employment due to redistribution by estimating the excess of public employees and wage premium in the poorer regions compared to a benchmark economy. They calculate that about half of the public wage bill in the south of Italy can be identified as a subsidy. They conclude that both the size of public employment and the level of public wages are used as redistributive devices.

Gimpelson and Treisman (2002) develop a two-period game played by the central executive and subnational governors to explain the public employment difference at the regional level in Russia. In their model the politicians view public employment as a tool to increase their expected vote shares, by which public employment could be viewed as a good commitment device between politicians and voters. A number of results are consistent with their hypotheses. An interesting finding is that the level of public sector

employees at the jurisdiction with an "opposite governor" tends to be higher.[8]

In summary, we find that not only economic development may influence the level of public employees, but some political motivations also do. However, we do not know any cross country study that examines empirically the rent-seeking model. We suspect the reason is the qualitative property of political variables. As we will cover in the empirical chapter of this dissertation, we know that there are some dummy variables that are able to describe the political relationship between the central and subnational governments. However, this political relationship is always a matter of degree and not a matter of a closed question with a yes or a no answer. Therefore, a dummy variable may be misleading. This problem may become more serious when we do the cross-country comparison.[9]

Social Insurance Hypothesis

Besides the hypothesis based on Wagner's law, most studies we have discussed so far have argued that the difference of the level of public employment is determined by political reasons: governments use public employment as a tool for generating and redistributing rents. Rodrik (1996, 1997) suggests an alternative hypothesis to explain this difference: relatively safe government jobs represent partial insurance against undiversifiable external risk faced by the domestic economy. He argues that countries with great exposures to external risk are likely to have higher levels of public employees. Rodrik's (1997) model shows how public employment can play a welfare-enhancing

[8] They define an opposite local governor as a governor in ethnic republics with locally credible bases on which to allege central mistreatment and being affiliated with the communist opposition to incumbent president Yeltsin.
[9] See Chapter Four for more discussion on the political variable issue.

social insurance role in an economy buffered by external risks. In his empirical work, he uses the *Labor Market Data Base* assembled by the World Bank and the maximum sample size for his regression model is 76 countries (cross section data). In view of this small sample size, he supplements his analysis on employment with data on real government consumption as a share of GDP. His empirical result shows that exposure to external risk, measured as the share of the sum of imports and exports of goods and services on GDP, is robustly associated with levels of government employees across countries. Although there is enough evidence to suggest that the rent hypothesis cannot be dismissed, as discussed before, a more benign motive, that of providing social insurance through job creation, accounts well for cross-country differences in the extent of public employment.

Rama (1997) uses the same measure of exposure to external risk as employed by Rodrik (1996) but increases the country sample and time period (unbalanced panel data) to explain the difference of the level of public employees across countries. Rama's (1997) empirical work shows that the level of government employees increases significantly with exposure to external risk, as first claimed by Rodrik (1997).

There are still some other factors that have been found to be able to explain the differences in the level of public employees across countries. For example, Kraay and van Rijckeghem (1995) find that the level of government employees is negatively associated with government debt. Besides this, they also find that governments hire counter-cyclically and according to the degree of urbanization. Political pressure, caused by high unemployment rates, might raise demand for public sector jobs as a counter-cyclical device. In addition, urbanization stimulates the demand for certain pubic services, such as

infrastructure, social order etc., which drives the public sector to increase government employees. Rama (1997) points out that the level of public sector employees appears to be higher in Latin America and South Asia. The hypothesis that all the regional dummies are equal to zero is rejected at the 5% significant level. Therefore, regional features may explain a certain portion of the variance in government employment across countries. Marques-Sevillano and Rossello-Villallonga (2004) argue that the difference could be explained by the dependency ratio.[10] They find that the number of public employees at the regional government in Spain increases with the dependency ratio. This is because the dependency ratio might be associated to the demand for education and health, which drives the government to hire more employees to provide such services.

Public Employment and Decentralization in the Previous Literature

In this section, we review the previous studies that link public sector employment and fiscal decentralization.[11] As we have mentioned above, most of the previous literature does not directly discuss the relationship between fiscal decentralization and public sector employment, except for Marques-Sevillano and Rossello-Villallonga (2004). In the first part of this section, we review prior studies on the relationship between fiscal decentralization and public sector size, measured as the ratio of either government expenditures or revenues to GDP. Then, we introduce Marques-Sevillano and Rossello-Villallonga's (2004) empirical study, which directly addresses the issue of the impact of fiscal decentralization on public sector employment in Spain.

The earliest argument to address the impact of fiscal decentralization on public

[10] They define the dependency ratio as the share of population at the age greater than 65 or less than 16 over total employment instead of population.
[11] For more detail about the definition of fiscal decentralization, please refer to Chapter Four.

sector size could be tracked back to Musgrave (1959). He argues that under a highly decentralized public sector, there is likely to be comparatively little in the way of assistance to the poor for two reasons. First, sorting out along Tiebout lines implies relatively income-homogeneous jurisdictions with little scope for redistribution from the rich to the poor within jurisdictions. Second, the fear of attracting the mobile poor with relatively generous support programs tends to deter the adoption of such programs. Both reasons suggest that the scope for public relief programs will be more constricted under a relatively decentralized fiscal system. In other words, a comparatively larger budget is expected under a highly centralized government because of a greater demand for assistance to the poor.

Brennan and Buchanan's (1980) Leviathan hypothesis is another classic argument in the discussion of the relationship between decentralization and public sector size. In their model, government is a monolithic entity, whose goal is to maximize fiscal revenues. This can only be limited by constitutional constraints. According to their hypothesis, decentralization of tax and spending decisions introduces competition among governmental units seeking to attract citizens and other mobile resources, and thereby constrains its access to tax and other fiscal instruments. In short, the Leviathan hypothesis implies that, other things being equal, the size of the public sector should vary inversely with the extent of fiscal decentralization, which is consistent with Musgrave's (1959) argument.

Both the Musgrave's (1959) and Brennan and Buchanan's (1980) points of view are based on the perspective of allocation efficiency and they support that decentralization would lead to a small public sector. However, there is another point of

view that argues the size of public sector increases with the context of fiscal decentralization. A first argument by Oates (1972, 1985) is that greater decentralization may result in the loss of certain economies of scale with a consequence increase in administration costs. The Leviathan hypothesis has been criticized that it ignores the supply efficiency. If economies of scale in the provision of public services are substantial, decentralization may result in a larger public sector (Stein, 1998). Moreover, since the central government is more likely to offer qualified people better career and individuals tend to choose offers with more possibilities for promotion, the resulting poor quality of subnational bureaucrats is likely to reduce the benefits of decentralization and result in weak public expenditure management and higher supply costs of public services (Prud'homme, 1995).

A second argument is made on the basis of political participation by Wallis.[12] Wallis argues that since individuals have more control over public decisions at the subnational than at the national level, they will wish to empower the public sector with a wider range of functions and responsibilities carried out at more localized levels of government. As a result, the level of subnational government employment grows with the degree of fiscal decentralization. Based on these two arguments, we expect that the public sector tends to be larger with a higher degree of fiscal decentralization.

In practice, there is a good number of empirical studies seeking to test the Leviathan hypothesis, such as Giertz (1983), Oates (1985), Nelson (1987), Wallis and Oates (1988), Zax (1989) and Forbes and Zampelli (1989). However, neither of these studies measures the public sector size by the number of public employees because the Leviathan hypothesis suggests to focus on the level of revenue that the state extracts from

[12] Wallis' argument has been cited in Oates (1985).

the economy. Besides the revenue-related variables, such as government tax revenues as a fraction of personal income that has been used in Forbes and Zampelli (1989), Giertz (1976), Nelson (1987), Oates (1985) and Zax (1989), other measures, such as government expenditures as a fraction of personal income, are used to measure the size of public sector as well, for example, Giertz (1983), Oates (1985) and Oates and Wallis (1988). Empirically, there is no consistent evidence to support or to reject the Leviathan hypothesis. While Wallis and Oates (1988) and Zax (1989) find supporting evidence for the Leviathan hypothesis, Giertz (1983), Oates (1985), Nelson (1987) and Forbes and Zampelli (1989) reject it.

So far, there appears to be only one empirical study by Marques-Sevillano and Rossello-Villallonga (2004), explaining how the number of public employee at the regional government is influenced by the process of decentralization. These authors define the process of fiscal decentralization as the transfer of responsibilities of education and health from the central to the regional governments. In their empirical study, they group the regional governments in Spain at that time according to whether they have received or not these two responsibilities to measure the process of fiscal decentralization.[13] The regional governments with receiving both responsibilities are grouped as highly decentralized group. The regional governments with receiving only the responsibility of education are grouped as middle decentralized group. The control group is those regional governments with none of these two responsibilities.

Due to the process of decentralization that started in Spain in the 1980s, 17 regional governments have been created and public employment needs have not been entirely covered with employees transferred from the central government. The data from

[13] Nowadays all regional governments in Spain have been transferred education and health.

their empirical study shows that the increase in the number of public employees at the regional government level is 1.6 times the reduction of the public employees at the central government during the period from 1990 to 2003. That is the number of total public sector employees actually increased with the process of fiscal decentralization.

We are particularly interested in one of their empirical results. They find that the ratio of regional public employees to total employment is significantly greater in the regions receiving both responsibilities (education and health) from the central government vis-à-vis the rest of the regions. Our theoretical model below is inspired by this result. With the process of fiscal decentralization, the central government transfers some responsibilities to the regional governments, which drives the increase in regional government employees and the reduction in central government employees. The overall impact of fiscal decentralization on total public sector employees depends on these two opposing effects. If the magnitude of the increase overwhelms the reduction, then the number of total public sector employees increases with the process of fiscal decentralization. In this case, we confirm Oates' (1972, 1985) and Wallis'[14] argument that decentralization tends to result in a larger public sector. On the other hand, if the magnitude of increase is less than the reduction, the number of total public sector employees decreases with the process of fiscal decentralization. In this case, the point of view suggested by Musgrave (1959) and Brennan and Buchanan (1980) that decentralization leads to leaner government will be supported.

Moreover, we are also interested in identifying any factors that may influence the magnitude of these two effects. In the next chapter, we develop our own model with the aim of better explaining the differences in public sector employment across countries and

[14] Wallis' argument has been cited in Oates (1985).

answering the question we have presented whether the fiscal decentralization retrench the public sector employment or not.

Public Expenditures and Spatial Effects in the Previous Literature

As indicated in Chapter One, policy makers may be affected by their "neighbors" when they design their policy, which is known as spatial interaction or spatial effects. There is now a large literature showing that spatial effects play an important role in determining one country's fiscal policy. This literature has used different theoretical frameworks to rationalize the existence of spatial effects; these include spillover effects (Case *et al*., 1993) and yardstick competition (Besley & Case, 1995; Bordignon *et al*., 2003; Revelli, 2006). Regardless of the different theoretical explanations, the empirical estimation of these models typically follows a common empirical framework (Case *et al*., 1989). The spatial effects can be captured by using weight matrices which approximate the potential spatial correlation either in the dependent variables or in the error terms, or both.[15] In this section, we focus our review on the literature on spatial interaction on the expenditure side of the budget, since it directly links to the topic of our study, the level of public sector employment. Most of the previous empirical literature has used subnational level data to detect special effects, for example, Baicker (2001), Case *et al.* (1989), Case *et al.* (1993), Bordignon (2003) and Revelli (2006). Some other researches, such as Redoano (2003) and Mbakile-Moloi (2006) have used cross country data to detect spatial effects. Redoano (2003) found the evidence of spatial effects in terms of public expenditures, using a dataset for 13 European Union (EU) countries for the period 1985-

[15] The empirical model captures the potential spatial correlation in the dependent variable is called the spatial autoregressive model, in the error terms is called the spatial error model, and in both dependent variable and error terms is called the general spatial model.

1995.[16] His empirical shows that EU countries set their public expenditures at both the aggregated and disaggregated levels, interdependently. Mbakile-Moloi (2006) also detected evidence of spatial interaction on the expenditure side of the budget in 24 Southern African Development Community (SADC) Region countries and 11 Sub-Saharan Africa (SSA) countries. [17]

An interesting point of these two cross country studies is that both authors use a dataset of "homogenous" countries. For example, these 13 European Union countries that have been used in Redoano's (2003) empirical estimation are all OECD countries. Meanwhile, the 11 SSA countries and 24 SADC countries being used in Mbakile-Moloi's (2006) empirical estimation are all developing or undeveloped countries. The importance of this observation is that with a "homogenous" dataset, the presence of spatial effects might not be surprising since it is more possible for the policy maker of one country to be affected or follow the policy of the neighboring country with similar GDP level or infrastructure. There is also a greater chance that the spatial effects may be commingled with other common but unobserved factors. On the other hand, spatial effects may not exist between two neighbor but quite different countries, for example, one of which is OECD and the other is non-OECD country or one developed and the other developing. This is because with significant differences in institution, infrastructure and so on between these two countries, spillover effects may not take place and, thus, spatial effects may not be present. In particular, in many developing countries, politicians are not as

[16] These countries are United Kingdom, Germany, France, Ireland, Italy, Spain, Austria, Denmark, Finland, Greece, Netherlands, Sweden, and Portugal.

[17] These 24 SADC countries are Botswana, Burkina Faso, Burundi, Cameroon, Congo Dem. Rep, Djibouti, Ethiopia, Gambia, Ghana, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritius, Namibia, Nigeria, South Africa, Swaziland, Tanzania, Uganda, Zambia, Zimbabwe; these 11 SSA countries are Botswana, Congo Dem. Rep, Lesotho, Malawi, Mauritius, Namibia, South Africa, Swaziland, Tanzania, Zambia, Zimbabwe.

accountable to voters, and, therefore, yardstick competition may not be present. Both arguments suggest that using a geographic border or distance to detect spatial effects across countries may not be appropriate if the dataset includes both OECD and non-OECD or developed and developing countries. In this study, our dataset includes both OECD and non-OECD countries; therefore, the empirical methodology utilized for a weight matrix becomes very important. In our empirical work, we divide the countries into six groups: Africa, Asia, Eastern Europe and former Soviet Union, Latin America and the Caribbean, the Middle East and North Africa, and OECD.[18] Countries in the same group are likely to have similar culture or socio-economy background, and are more likely to affect each other through spatial effects. In such a setting, given two countries being in the same group, these two countries are viewed as neighbors, independently of whether they share the same border or not. Once the way of creating our weight matrix has been decided, it will be used to detect spatial effects in terms of public sector employment level for all the countries in our dataset. The weight matrix and our empirical results are presented in Chapter Four.

[18] This categorization has been used in the empirical analysis of Schiavo-Campo *et al.* (1997b).

CHAPTER THREE: THEORETICAL MODEL

In this chapter, we develop our theoretical model expanding on the work by Gimpelson and Treisman (2002). We model the fiscal politics that determines the level of public employees as a two-stage game played between the central government and a subnational government. Politicians in this model act as what Niskanen (1968) calls bureaucrats who seek to maximize their own utility function.[19] According to him, there are several variables that may enter the bureaucrat's utility function, such as salary, public reputation and output of the bureau. In our model, we assume that the bureaucrat's utility function consists of two components: the level of public goods provided to the residents and subnational government budget gap. The bureaucrat's utility is positively associated with the level of public goods provided and inversely with negative subnational government budget gap.

We assume that there are two types of public goods: local public goods and national public goods. Local public goods are only provided to the residents in the particular jurisdiction following the decision of the governor in this jurisdiction. National public goods are provided to all residents in the country following the decision of the central authorities. The production functions of both public goods are of a Cobb-Douglas form with two inputs, labor (public sector employment) and capital, which could be represented mathematically as:

$$f(m,K) = m^{\alpha} \cdot K^{\beta}$$

[19] According to Niskanen (1971), bureaucracy has two basic characteristics: they are non-profit organizations, and they are financed, at least in part, from a periodic appropriation or grant.

where m is input of public sector employment and K is capital input.[20] We further assume that the production technologies of local pubic goods in each jurisdiction are identical. Thus, these two production coefficients, α and β, are constant across jurisdictions in the country. All public expenditures go to pay the wages of the public employees and the capital rental costs.

The model is set up as follows. Assume there is a country composed of one central government with an executive and n jurisdictions, subscripted $i = 1,2,...,n$, each with an governor and the same number of residents. The total amount of national resources in this country are denoted by $\overline{R}$, which are financed by a national proportional income tax, $t \cdot Y$, where t is the fixed tax rate and Y is the real GDP. In period 1, the central government sets the degree of fiscal decentralization, θ, which is the share of $\overline{R}$ that allocates equally to the subnational governments, and the rest share, $(1-\theta)$, is kept by the central government.[21] We denote the amount of resource allocated to jurisdiction i as r_i, where $r_i = \frac{\theta \cdot \overline{R}}{n}$. Thus the budget constraints for central and each subnational government are $(1-\theta) \cdot \overline{R}$ and $\frac{\theta \cdot \overline{R}}{n}$, respectively. In period 2, the subnational governor in jurisdiction i receives the transfers, $\frac{\theta \cdot \overline{R}}{n}$, and sets the level of public employees in its

[20] In reality, the public sector might have certain level of control over the prices of labor and capital; however, for the purpose of simplicity, we assume the prices are fixed and we normalize them to 1. This assumption also implies that the labor supply is a horizontal line and unemployment is not allowed.

[21] This assumption might be true, especially in developing countries. Although the subnational governments in developing countries have their own-source revenues, they usually do not have full autonomy in these revenues: subnational governments are authorized to collect the tax but not allowed to change the tax rate or tax base without the permission of the central government. This implies that the central government can decide the subnational revenue level by setting the tax rates and tax bases of subnational revenues. Therefore, total amount of national resources in this country are controlled by the central government.

jurisdiction, denoted by m_i. If we follow Bird and Vaillancourt (1998), this process of fiscal decentralization is what has been termed a delegation: the subnational governor has the authority to decide the level of public goods provided in this jurisdiction but the discretion to raise taxes is limited.[22]

As we have assumed that the bureaucrat's utility function consists of the level of local public goods provided to the residents and subnational government deficits, and it is positively correlated to the level of local public goods and inversely correlated to the negative budget gap, the utility function of the subnational governor in jurisdiction i, $E(V_i)$, can be shown as:

$$E(V_i) = f(m_i) - (1-\sigma)\cdot\pi(c_i)$$

where m_i, $f(m_i)$ and c_i are the amount of public employees, the production function of local public goods and the subnational government budget gap ratio in jurisdiction i, respectively. The subnational government budget gap ratio in jurisdiction i is defined as the ratio of budget gap to revenue. The subnational governor in jurisdiction i chooses to hire the amount of m_i public employees to maximize his utility and provide the level of $f(m_i)$ local public goods to the residents in this jurisdiction. We assume the production function is a concave function, that is, $f'(m_i) > 0$ and $f''(m_i) < 0$, $\forall m_i > 0$. The level of local public goods of jurisdiction *i* is given by $f(m_i, K_i) = m_i^{\alpha}\cdot K_i^{\beta}$. In equilibrium, we have $K_i^* = m_i^*\cdot\beta/\alpha$, and the total expenditure of jurisdiction *i* is $m_i^*\cdot(1+\beta/\alpha)$. In addition, the production function can be reduced to $f(m_i) = m_i^{\alpha}\cdot(m_i\cdot\beta/\alpha)^{\beta} = (\beta/\alpha)^{\beta}\cdot m_i^{\alpha+\beta}$.

[22] For more detail of the definition of fiscal decentralization see Chapter Four of this dissertation.

In the objective function, $\pi(c_i)$ is the political cost function of a subnational budget gap, which is caused by over-staffing in this jurisdiction. We assume that the subnational governments are able to finance the gap via other sources, for example, borrowing from subnational-government-own banks. Such subnational government budget constraints are so-called "soft budget constraints."[23] The budget gap ratio of jurisdiction i can be represented by $\frac{m_i \cdot (1+\beta/\alpha) - r_i}{r_i}$, or $\frac{m_i \cdot (1+\beta/\alpha)}{r_i} - 1$, where $m_i \cdot (1+\beta/\alpha)$ and r_i are the expenditure and revenue of jurisdiction i. $c_i < 0$ means that there is a positive budget gap, $c_i > 0$ means there is a negative budget gap, and $c_i = 0$ means that the budget gap is zero in jurisdiction i. We assume the political cost is zero as $c_i \le 0$ and it is positive and a convex function as $c_i > 0$, that is, $\pi(c_i) > 0$, $\pi'(c_i) > 0$ and $\pi''(c_i) > 0$, $\forall c_i > 0$. To assure the existence of a solution and to avoid a corner solution, we need further assumptions for this utility maximization problem: $f'(m_i) \to \infty$ as $m_i \to 0$, $f'(m_i) \to 0$ as $m_i \to \infty$, $\pi'(c_i) \to 0$ as $c_i \to 0$, and $\pi'(c_i) \to \infty$ as $c_i \to \infty$.

With soft budget constraints, the subnational governments can increase expenditures without eventually facing the full cost (Rodden *et al*., 2003). The coefficient, σ, with the value between 0 and 1, captures this political relationship between the central and subnational governments in the country. It determines the ratio of the political cost, $\pi(c_i)$, that is shifted from the subnational governor to the central executive. So, $(1-\sigma) \cdot \pi(c_i)$ captures the political costs that remain with the subnational government.

[23] The term soft budget constraint was first introduced by Kornai (1992) to describe how state-own enterprises could rely on increased subsidies if they increased their loss. Rodden *et al.* (2003) provide an appropriate definition for our model: A soft budget constraint describes the situation when an entity (say, a subnational government) can manipulate its access to funds in undesirable way.

There are three properties in the subnational bureaucrat's utility function. First, if the subnational government provides higher level of public goods, the subnational governor obtains higher level of utility. Second, hiring too many employees causes a high level of negative subnational government budget gap, which is harmful to the subnational governor's utility function. In the model, $(1-\sigma)\cdot\pi(c_i)$ is the penalty to the subnational government for over-staffing. A rational governor would set $m_i = m_i^*$, such that $c_i^* = \frac{n\cdot m_i^*\cdot(1+\beta/\alpha)}{\theta\cdot\overline{R}} - 1 > 0$, where m_i^* and c_i^* are the reaction function of the governors of jurisdiction i with respect to the central executive's decision in period 1. The proof is straightforward as below:

The utility maximization problem for the governor of jurisdiction i is defined as:

$$\max_{\{m_i\}} E(V_i) = f(m_i) - (1-\sigma)\cdot\pi(c_i) \qquad \text{subject to} \qquad c_i = \frac{n\cdot m_i\cdot(1+\beta/\alpha)}{\theta\cdot\overline{R}} - 1.$$

Solving the utility maximization problem, we have the following first order condition:

$$\frac{\partial E(V_i)}{\partial m_i} = f'(m_i) - (1-\sigma)\cdot\pi'(c_i)\cdot\left[\frac{n\cdot(1+\beta/\alpha)}{\theta\cdot\overline{R}}\right] = 0.$$

Let F be the first order condition, and we have

$$F = f'(m_i) - (1-\sigma)\cdot\pi'(c_i)\cdot\left[\frac{n\cdot(1+\beta/\alpha)}{\theta\cdot\overline{R}}\right].$$

The second order condition is

$$\frac{\partial F}{\partial m_i} = f''(m_i) - (1-\sigma)\cdot\pi''(c_i)\cdot\left[\frac{n\cdot(1+\beta/\alpha)}{\theta\cdot\overline{R}}\right]^2.$$

Since $f'' < 0$, $(1-\sigma) > 0$, and $\pi''(c_i) > 0$, the second order condition is negative and satisfied for a utility maximization problem. It implies that the solution for this utility

maximization problem exists. We denote the reaction function of the subnational governor of jurisdiction *i* as m_i^* and $m_i^* = m_i(\theta, \sigma, \alpha, \beta, n, \overline{R})$. Consequently, we have

$$c_i^* = \frac{n \cdot m_i^* \cdot (1+\beta/\alpha)}{\theta \cdot \overline{R}} - 1 = c_i(\theta, \sigma, \alpha, \beta, n, \overline{R}).$$

Since $f'(m_i^*) > 0$, $(1-\sigma) > 0$ and α, β and r_i are all positive, we have $\pi'(c_i^*) > 0$. Because $\pi(c_i) = 0$ as $c_i \le 0$ and $\pi(c_i)$ is a convex function as $c_i > 0$, we have shown that $c_i^* > 0$.

The intuition behind this argument is that since the over-staffing cost to the subnational government is proportionally shared by the central government, a rational subnational governor would choose to over-staff until the marginal benefit of providing public goods equals the marginal cost he needs to bear and ask the central executive to pay part of the bill of subnational over-staffing. We can further show that the level of c_i^* depends on the value of σ: the higher the value of σ, the higher the level of c_i^*.[24]

Finally, the coefficient σ plays the essential political role in our model. Within the country the extent of the political cost to the governor depends on whom voters blame for the negative budget gap. In some countries, the public views the negative subnational budget gap as a failure of the negotiation and crisis management skills of the central government, even if objectively the subnational governments are more directly to be blamed. We use σ, with the value between 0 and 1, to measure the propensity of voters

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[24] Since $c_i^* = \frac{n \cdot m_i^* \cdot (1+\beta/\alpha)}{\theta \cdot \overline{R}} - 1$, we have $\frac{\partial c_i^*}{\partial \sigma} = \frac{n \cdot (1+\beta/\alpha)}{\theta \cdot \overline{R}} \cdot \frac{\partial m_i^*}{\partial \sigma}$. The sign of $\frac{\partial c_i^*}{\partial \sigma}$ is determined by $\frac{\partial m_i^*}{\partial \sigma}$. We will show that $\frac{\partial m_i^*}{\partial \sigma} > 0$ in Proposition 3 below. Since $\frac{\partial m_i^*}{\partial \sigma}$ is positive, we know that $\frac{\partial c_i^*}{\partial \sigma}$ is positive as well.

to blame the central government rather than the subnational government for the negative budget gap of their jurisdiction. The higher the value of the political variable σ, the larger the proportion of the political cost of negative subnational government gap that is shifted to the central executive. We expect the value of σ is higher in some countries, where subnational governments have less autonomous power in comparison to other countries with a lower value of σ, where subnational governments have more autonomy, in particular autonomy to raise their own taxes. For example, in countries like Greece and Hungry, the subnational governors do not have power to collect a new tax or even raise or reduce the tax rate. [25] They can only execute the expenditure or revenue policies enacted by the central government and act as the agent of the central government executive. Under these circumstances, subnational governments can more easily shift the political costs of negative subnational budget gap to the central government. On the other hand, in other countries, like the United States and Canada, each subnational government has more autonomy in managing subnational government finances. Thus, subnational governors in these countries would have to bear a larger part of the penalty of the negative subnational government gap.

Now let us turn our attention to the central government executive's utility maximization problem. The central government executive's utility consists of two components: the level of national public goods provided to all residents in the country and negative subnational government budget gaps. As was in the case of the subnational governor utility, the central government executive's utility is positively correlated to the level of national public goods and is negatively correlated to the negative subnational

[25] We will discuss more detail about the political variable in the next chapter.

budget gap. The central government executive's utility function, $E(V_c)$, can be shown as:

$$E(V_c) = g(1-\theta) - \sigma \cdot \sum_{i=1}^{n} \pi(c_i)$$

where $g(1-\theta)$ can be viewed as the production function of national public goods.[26] The coefficient σ is the share of the political cost of negative subnational government budget gaps that the central executive has to bear, and $\sum_{i=1}^{n} \pi(c_i)$ is the total subnational government budget gaps in the country. Again, we assume the production function is a concave function, that is, $g(1-\theta)' > 0$ and $g(1-\theta)'' < 0$, $\forall 0 < (1-\theta) < 1$. The central executive chooses a degree of fiscal decentralization to maximize his utility. To assure the existence of an inner solution, we further assume that $g(1-\theta)' \to \infty$ as $\theta \to 1$, and $g(1-\theta)' \to 0$ as $\theta \to 0$. In equilibrium, the optimal degree of fiscal decentralization can be shown mathematically as $\theta^* = \theta(\sigma, \alpha, \beta, n, \overline{R})$. Once θ^* is determined, the optimal level of central government employees, m_c^*, is also determined, which is given by

$$m_c^* = \left(\frac{\alpha}{\alpha + \beta} \right) \cdot (1-\theta^*) \cdot \overline{R} = m_c(\sigma, \alpha, \beta, n, \overline{R}).$$

There are two important properties of the central executive's utility function. First, the utility increases with the provision of national public goods, $g(1-\theta)$, as was the case for the subnational governor. Second, the central government executive has to bear part of political cost caused by the negative subnational government budget gap, which is

[26] We assume that there is no budget deficit problem in the central government level, and, therefore, the total expenditure for the central government is $(1-\theta) \cdot \overline{R}$. Given the property of production function of a Cobb-Douglas form and total expenditure of the central government, we can know the level of national public goods provided. If we release this assumption and allow the central government has a limited budget deficit, our result will be essentially the same.

harmful to the central executive's utility. The share that the central government has to bear is σ; as a result, the penalty function for the central government is given by $\sigma \cdot \sum_{i=1}^{n} \pi(c_i)$.

The intuition of our theoretical model is that the subnational governor's objective is to maximize his utility and the only way to do so is through providing more local public goods to his constituency. However, given the subnational government budget constraint, providing too much public goods causes high level of negative subnational government budget gap, which lowers his utility. Therefore, there is a trade-off between providing local public goods and bearing negative budget gap in the subnational governor's decision. By the same token, the central government executive's objective is to increase his utility. He can increase his utility through providing more national public goods to the people in this country. The only way for the central government to provide more national public goods is to set up a lower degree of fiscal decentralization. However, a very low degree of fiscal decentralization ratio means a very low level of resources going to the subnational government, which causes a high level of negative budget gap in the subnational government and indirectly lowers his utility.[27] This is because in some countries, the public views negative subnational budget gaps as a failure of the negotiation and crisis management skills of the central government, even if objectively the subnational governments are more directly to be blamed. Therefore, both the central government executive and the subnational governor need to bear the political cost of

[27] For example, if $\theta \to 0$, then $g(1-\theta)' \to 0$ and $c_i \to \infty$. Based on the inner solution assumption for subnational governor's utility maximization problem, we know $\pi(c_i) \to \infty$ as $c_i \to \infty$. Therefore, if $\theta \to 0$, then $E(V_c) \to -\infty$. This implies that a rational central executive will not set up a zero degree of fiscal decentralization.

negative subnational budget gaps. We introduce a political variable, σ, into our model to represent the share of the political cost of negative subnational budget gaps that the central executive has to bear. We again see a trade-off relationship between setting up a lower degree of fiscal decentralization and bearing the cost of negative subnational budget gaps in the central executive's decision. In addition, these two decision makers are linked by the political variable, σ. In our Proposition Three we show that the political variable plays an important role in determining the level of public employees at both the central and subnational governments.

Figure 1 helps us understand the intuition of our model. The purpose of building this theoretical model is to find out the effect of some exogenous variables on the subnational governor's decision of hiring public employees and the central government executive's decision of choosing the degree of fiscal decentralization. Moreover, we want to examine how the central government executive's decision affects the subnational governor's decision. In order to investigate the interaction of the decisions of the central government executive subnational governor, we use, as already mentioned, a game theoretic approach. We can solve the two-period-two-player game by applying backward induction.[28] In period 2, the subnational governor in jurisdiction i sets the level of public employees in this jurisdiction, m_i, to maximize his utility function:

$$\max_{\{m_i\}} E(V_i) = f(m_i) - (1-\sigma)\cdot\pi(c_i) \quad \text{subject to} \quad c_i = \frac{n\cdot m_i \cdot (1+\beta/\alpha)}{\theta\cdot\overline{R}} - 1. \qquad (1)$$

By solving the maximization problem, we have the following first order condition:

[28] Since we assume that these *n* jurisdictions are all identical, we can focus on one particular subnational governor's reaction to the central executive's decision. Of course, this assumes that subnational governments do not collude among themselves and that every subnational government is too small to really affect what happens to other subnational governments.

$$F = \frac{\partial E(V_i)}{\partial m_i} = f'(m_i) - (1-\sigma)\cdot \pi'(c_i)\cdot\left[\frac{n\cdot(1+\beta/\alpha)}{\theta\cdot\overline{R}}\right] = 0. \quad (2)$$

Denote the reaction function of the subnational governor in jurisdiction *i* as

$m_i^* = m_i(\theta,\sigma,\alpha,\beta,n,\overline{R})$ and, therefore, we have $c_i^*(\theta,\sigma,\alpha,\beta,n,\overline{R}) = \frac{n\cdot m_i^*\cdot(1+\beta/\alpha)}{\theta\cdot\overline{R}} - 1.$

The second order condition, $\frac{\partial F}{\partial m_i} = f''(m_i) - (1-\sigma)\cdot\pi''(c_i)\cdot\left[\frac{n\cdot(1+\beta/\alpha)}{\theta\cdot\overline{R}}\right]^2$, has been shown to be negative and satisfied for a utility maximization problem, which assures the existence of the solution.[29]

In period 1, the central government executive sets the degree of fiscal decentralization, θ , to maximize his utility function:

$$\max_{\{\theta\}} E(V_c) = g(1-\theta) - \sigma\sum_{i=1}^{n}\pi(c_i) \quad \text{subject to} \quad c_i^* = \frac{n\cdot m_i^*\cdot(1+\beta/\alpha)}{\theta\cdot\overline{R}} - 1. \quad (3)$$

We insert the constraint into the objective function and the central government executive's utility maximization problem can be shown as:

$$\max_{\{\theta\}} E(V_c) = g(1-\theta) - \sigma\sum_{i=1}^{n}\pi\left(\frac{n\cdot m_i^*\cdot(1+\beta/\alpha)}{\theta\cdot\overline{R}} - 1\right).$$

The corresponding first order condition is

$$G = \frac{\partial E(V_c)}{\partial\theta} = -g'(1-\theta) - \sigma\sum_{i=1}^{n}\pi'\cdot\frac{n\cdot(1+\beta/\alpha)}{\theta\cdot\overline{R}}\cdot\left(\frac{\partial m_i}{\partial\theta} - \frac{m_i}{\theta}\right) = 0. \quad (4)$$

We assume that the second order condition is satisfied for this utility maximization problem, which implies $\frac{\partial G}{\partial\theta} < 0$. This assures the existence of the solution of the central government. We denote the solution to the central government executive's utility

[29] Please see the proof of the second property of the subnational bureaucrat's utility function.

maximization problem as $\theta^* = \theta\left(\sigma, \alpha, \beta, n, \overline{R}\right)$ and, therefore, the level of central government employment is determined by $m_c^* = m_c\left(\sigma, \alpha, \beta, n, \overline{R}\right) = \frac{\alpha \cdot \overline{R}}{\alpha + \beta} \cdot \left(1 - \theta^*\right)$.

Total public sector employment and the degree of fiscal decentralization in this country can be shown mathematically as:

$$m^* = m_c^* + n \cdot m_i^* = m_c\left(\sigma, \alpha, \beta, n, \overline{R}\right) + n \cdot m_i\left(\theta^*, \sigma, \alpha, \beta, n, \overline{R}\right) = m^*\left(\alpha, \beta, \sigma, n, \overline{R}\right)$$

and

$$\theta^* = \theta\left(\alpha, \beta, \sigma, n, \overline{R}\right).$$

We are now ready to derive some propositions, which help us to establish the potential impact of some exogenous variables on the subnational governor's decision of hiring public employees and the central government executive's decision of choosing the degree of fiscal decentralization. In addition, we will be able to predict the reaction of the subnational governor to the central executive's decision.

Proposition One: The reaction function for the level of public employees in jurisdiction i, m_i^*, increases with the degree of fiscal decentralization, θ, decided by the central government in period 1. In addition, that the optimum level of central government employment, m_c^*, decreases with the degree of fiscal decentralization. Thus, the impact of fiscal decentralization on total public employees is ambiguous.

First, we prove that the reaction level of public employees of the subnational government *i*, m_i^*, increases with the degree of fiscal decentralization. The function F denotes the first order condition of the utility maximization problem of the subnational governor in jurisdiction *i,* and we have

$$F = \frac{\partial E(V_i)}{\partial m_i} = f'(m_i) - (1-\sigma)\cdot \pi'(c_i)\cdot\left[\frac{n\cdot(1+\beta/\alpha)}{\theta\cdot\overline{R}}\right] = 0.$$

Applying the implicit function theorem, we have

$$\begin{aligned}\frac{\partial m_i^*}{\partial \theta} &= -\frac{\partial F/\partial\theta}{\partial F/\partial m_i} \\ &= -\frac{-(1-\sigma)\cdot\left[\pi''\cdot\frac{n\cdot(1+\beta/\alpha)}{\theta\cdot\overline{R}}\cdot\left(-\frac{n\cdot m_i\cdot(1+\beta/\alpha)}{\theta^2\cdot\overline{R}}\right)+\pi'\cdot\left(-\frac{n\cdot(1+\beta/\alpha)}{\theta^2\cdot\overline{R}}\right)\right]}{f''-(1-\sigma)\cdot\pi''\cdot\left[\frac{n\cdot(1+\beta/\alpha)}{\theta\cdot\overline{R}}\right]^2} > 0.\end{aligned} \quad (5)$$

Since $f''<0$ and $\pi''>0$, the sign of Equation (5) is positive, which satisfies our expectation. The higher the degree of fiscal decentralization, the higher the share of national resources that go to the subnational governments and the less the national resources that are controlled by the central government. Since all the expenditures are exhausted to pay the wage of public employees and the capital rental costs, a high degree of fiscal decentralization would drive the level of subnational government employees to increase.

Second, we explain why the level of central government employees, m_c^*, decreases with the degree of fiscal decentralization. Given the assumption that there is no budget deficit in the central government, the central government budget constraint is $(1-\theta)\cdot\overline{R}$. Since there are only two inputs in the production function of public goods, the total expenditure of the central government can be expressed as $m_c^*\cdot(1+\beta/\alpha)$. Given no central government deficit assumption, we have $m_c^* = \frac{\alpha\cdot\overline{R}}{\alpha+\beta}\cdot(1-\theta^*)$. From this equation, we know the that level of central government employees, m_c^*, moves inversely with the level of fiscal decentralization, θ.

Since fiscal decentralization leads to an increase in the number of public employees at the subnational government level and a decrease at the central government level, the overall impact of fiscal decentralization on total public sector employment is ambiguous and depends on the relative dimensions of these two opposing effects. If the magnitude of the former effect overwhelms the latter, total public sector employment increases with the degree of fiscal decentralization; otherwise, public sector employment decreases with it. The exogenous variable, σ, plays an important role in determining the magnitude of these two effects; however, from the model we cannot find this relation since the sign of $\frac{\partial}{\partial \sigma}\left(\frac{\partial m_i^*}{\partial \theta}\right)$ is ambiguous, which leaves this issue to be resolved in our empirical estimation.

Proposition Two: From our theoretical model, we expect that a positive relationship exists between GDP and subnational government employment, but this relationship does not apply to GDP and central government employment. We first show the proof of the first part of this proposition and then present a potential reason why this positive relationship does not exist between GDP and central government employment level:

By the chain rule, we have

$$\frac{\partial m_i^*}{\partial Y} = \frac{\partial m_i^*}{\partial \overline{R}} \cdot \frac{\partial \overline{R}}{\partial Y}. \tag{6}$$

To establish the sign of $\frac{\partial m_i^*}{\partial \overline{R}}$, we apply the implicit function theorem and obtain

$$\frac{\partial m_i^*}{\partial \overline{R}} = -\frac{\partial F / \partial \overline{R}}{\partial F / \partial m_i}$$
$$= -\frac{-(1-\sigma)\cdot\left[\pi''\cdot\frac{n\cdot(1+\beta/\alpha)}{\theta\cdot\overline{R}}\cdot\left(-\frac{n\cdot m_i\cdot(1+\beta/\alpha)}{\theta\cdot\overline{R}^2}\right)+\pi'\cdot\left(-\frac{n\cdot(1+\beta/\alpha)}{\theta\cdot\overline{R}^2}\right)\right]}{f''-(1-\sigma)\cdot\pi''\cdot\left[\frac{n\cdot(1+\beta/\alpha)}{\theta\cdot\overline{R}}\right]^2} > 0. \quad (7)$$

From Equation (7), we know that the sign of the first term of the right hand side of Equation (6) is positive. The sign of the second term of the right hand side of Equation (6) is positive as well because in the model we assume the national resource is financed by a proportional income tax, that is, $\overline{R} = t \cdot Y$. Thus,

$$\frac{\partial \overline{R}}{\partial Y} = t > 0\,. \quad (8)$$

Inserting Equation (7) and Equation (8) into Equation (6), we have

$$\frac{\partial m_i^*}{\partial Y} = \frac{\partial m_i^*}{\partial \overline{R}}\cdot\frac{\partial \overline{R}}{\partial Y}$$
$$= \frac{(1-\sigma)\cdot\left[\pi''\cdot\frac{n\cdot(1+\beta/\alpha)}{\theta\cdot\overline{R}}\cdot\left(-\frac{n\cdot m_i\cdot(1+\beta/\alpha)}{\theta\cdot\overline{R}^2}\right)+\pi'\cdot\left(-\frac{n\cdot(1+\beta/\alpha)}{\theta\cdot\overline{R}^2}\right)\right]}{f''-(1-\sigma)\cdot\pi''\cdot\left[\frac{n\cdot(1+\beta/\alpha)}{\theta\cdot\overline{R}}\right]^2}\cdot t > 0. \quad (9)$$

The sign of Equation (9) is positive, which implies that the level of public employees of the subnational government i , m_i^* , increases as GDP increases.

Second, we want to find out the effect of GDP on the central government employment. Since the optimal level of central government employees is determined by $m_c^* = \frac{\alpha\cdot\overline{R}}{\alpha+\beta}\cdot(1-\theta^*)$, we have

$$\begin{aligned}\frac{\partial m_c^*}{\partial Y} &= \frac{\alpha\cdot\overline{R}}{\alpha+\beta}\cdot\left(-\frac{\partial\theta^*}{\partial Y}\right)+\frac{\alpha\cdot\left(1-\theta^*\right)}{\alpha+\beta}\cdot\frac{\partial\overline{R}}{\partial Y}\\ &= \frac{\alpha}{\alpha+\beta}\cdot\left[-\frac{\partial\theta^*}{\partial\overline{R}}\cdot\frac{\partial\overline{R}}{\partial Y}\cdot\overline{R}+\left(1-\theta^*\right)\cdot t\right]\\ &= \frac{\alpha\cdot t}{\alpha+\beta}\cdot\left[-\frac{\partial\theta^*}{\partial\overline{R}}\cdot\overline{R}+\left(1-\theta^*\right)\right].\end{aligned} \tag{10}$$

The sign of Equation (10) depends on the sign of $\frac{\partial\theta^*}{\partial\overline{R}}$. To establish this, we apply the implicit function theorem again. The function G represents the first order condition of the central government executive's utility maximization problem, and we have

$$G=\frac{\partial E\left(V_c\right)}{\partial\theta}=-g'\left(1-\theta\right)-\sigma\sum_{i=1}^{n}\pi'\cdot\frac{n\cdot\left(1+\beta/\alpha\right)}{\theta\cdot\overline{R}}\cdot\left(\frac{\partial m_i}{\partial\theta}-\frac{m_i}{\theta}\right)=0\,.$$

Applying the implicit function theorem, we have

$$\begin{aligned}\frac{\partial\theta^*}{\partial\overline{R}} &= -\frac{\partial G/\partial\overline{R}}{\partial G/\partial\theta}\\ &= -\frac{\sigma\cdot\sum_{i=1}^{n}\left[\pi''\cdot\frac{n^2\cdot m_i\cdot\left(1+\beta/\alpha\right)^2}{\theta^2\cdot\overline{R}^3}\cdot\left(\frac{\partial m_i}{\partial\theta}-\frac{m_i}{\theta}\right)+\pi'\cdot\frac{n\cdot\left(1+\beta/\alpha\right)}{\theta\cdot\overline{R}^2}\left(\frac{\partial m_i}{\partial\theta}-\frac{m_i}{\theta}\right)-\pi'\cdot\frac{n\cdot\left(1+\beta/\alpha\right)}{\theta\cdot\overline{R}^2}\left(\frac{\partial^2 m_i}{\partial\overline{R}\partial\theta}-\frac{\partial m_i/\partial\overline{R}}{\theta}\right)\right]}{\partial G/\partial\theta}.\end{aligned} \tag{11}$$

The sign of Equation (11) is ambiguous by our model; as a result, we are not able to predict the sign of our Equation (10).[30]

We explain the rationale of Proposition Two as the following. First, the inequality in Equation (9) satisfies our expectation. This result supports Wagner's law, which indicates that economic development creates demand for new types of government services. In order to provide more public goods, the subnational governor has to hire more public sector employees. Therefore, the level of public sector employment in the subnational governments increases with GDP. However, according to Equation (10), we

[30] There is a literature by Panizza (1999) that claims that the degree of fiscal centralization is negatively correlated with income per capita, which implies that the sign of Equation (11) is positive.

are not able to determine the impact of GDP on the central government employment. The reason is that since the subnational government employment level increases with GDP, the impact of GDP on subnational government budget gap is unpredictable. If that increase in GDP worsens the subnational government budget gap, the central executive might increase his utility by raising the degree of fiscal decentralization, which lowers the penalty from negative subnational government budget gaps to the central executive. Given the level of central government employment moves inversely to the degree of fiscal decentralization, the increase in GDP might lower the level of central government employees.

Total public sector employment of a country consists of the central and subnational government employees. From the first part of Proposition Two, we know that the impact of GDP on subnational government employment is positive, but from the second part we know that the impact of GDP on central government employment is not determined. As a result, we are not able to predict the impact of GDP on total public sector employment, which leaves us another empirical task, and we will cover it in Chapter Four.

Proposition Three: The level of subnational government employees increases with the proportion of political cost caused by negative subnational governmental budget gap that is shifted to the central government executive; on the other hand, the central government employment increases with that proportion. The proof of the proposition is as follows:

First, we want to prove the first part of this proposition. Applying implicit function theorem, we have

$$\frac{\partial m_i^*}{\partial \sigma} = -\frac{\partial F / \partial \sigma}{\partial F / \partial m_i} = -\frac{\pi' \cdot \frac{n \cdot (1+\beta/\alpha)}{\theta \cdot \overline{R}}}{f'' - (1-\sigma) \cdot \pi'' \cdot \left[\frac{n \cdot (1+\beta/\alpha)}{\theta \cdot \overline{R}}\right]^2} > 0 . \quad (12)$$

The denominator of Equation (12) is negative since it is the second order condition for the subnational governor's utility maximization problem. Equation (12) implies that the level of subnational government employment increases with the proportion of political cost caused by the negative subnational government budget gap that the central government has to bear.

Next, we want to determine the impact of the proportion of political cost of negative subnational government budget gap that is shifted to the central government, σ, on the level of central government employees. Since $m_c^* = \frac{\alpha \cdot \overline{R}}{\alpha + \beta} \cdot (1 - \theta^*)$, we have

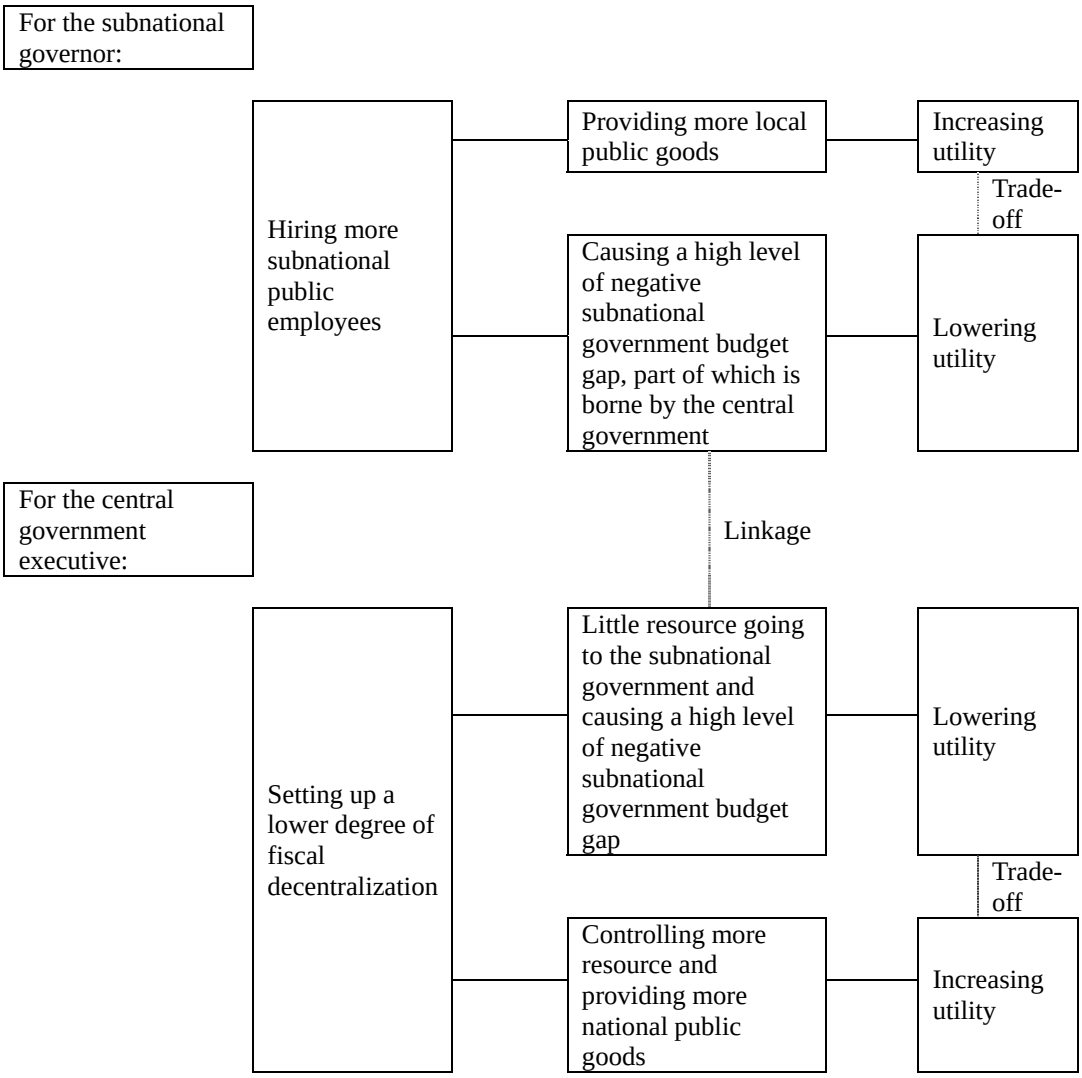
$$\frac{\partial m_c^*}{\partial \sigma} = -\frac{\alpha \cdot \overline{R}}{\alpha + \beta} \cdot \frac{\partial \theta^*}{\partial \sigma} . \quad (13)$$

Equation (13) shows that $\frac{\partial m_c^*}{\partial \sigma}$ and $\frac{\partial \theta^*}{\partial \sigma}$ have opposite signs. Although we cannot derive the sign of $\frac{\partial \theta^*}{\partial \sigma}$ from implicit function theorem directly, we can still determine it indirectly from some equations we have had so far. By the chain rule, we have $\frac{\partial \theta}{\partial \sigma} = \frac{\partial \theta}{\partial m_i} \cdot \frac{\partial m_i}{\partial \sigma}$. According to Equation (12), we have known that $\frac{\partial m_i^*}{\partial \sigma} > 0$. From our Proposition One, we know that $\frac{\partial m_i^*}{\partial \theta} > 0$.[31] Thus, we know that $\frac{\partial \theta^*}{\partial \sigma} > 0$. According to Equation (13), $\frac{\partial \theta^*}{\partial \sigma} > 0$ implies that $\frac{\partial m_c^*}{\partial \sigma} < 0$.

[31] Refer to Equation (5).

The overall effect of this political variable on the total public sector employment is ambiguous and depends on the impact of political cost on the central and subnational government employment, that is, it depends on the magnitudes of $\frac{\partial m_i^*}{\partial \sigma}$ and $\frac{\partial m_c^*}{\partial \sigma}$. The intuition of this proposition is quite straightforward. If the subnational governor is able to shift the political cost of negative subnational budget gap to the central executive easily, he is likely to hire more public employees to increase their utility and ask the central government executive to pay the bill. To reduce the disutility from negative subnational budget gap, the central government executive has to transfer a larger proportion of resource to the subnational governments. This reduces the public employees at the central government. The impact of the political variable on total public sector employment depends on these two opposing effects. If the increase of subnational government employees overwhelms the reduction of central government employees, total public sector employment increases with that political variable. If not, total public sector employment decreases. So the overall effect is not determined a priori and will have to be established empirically.

Figure 1: The Intuition of the Theoretical Model



CHAPTER FOUR: THE EMPIRICAL ANALYSIS

In the current chapter we develop the empirical framework that will support the estimation and also present the results. We start by defining public sector employment and some of the difficulties of defining this variable in the first section. Then in second section we define our measure of fiscal decentralization and also elaborate on some difficulties related to this variable. In the third section we restate our hypotheses derived from our theoretical model. In the fourth section we discuss how we apply the quantitative variable to the political variable we have introduced in our theoretical model. Then we review some econometric issues related to the estimation in the fifth section. In the final section we present the results and compare them to the previous findings in the literature.

The Definition of Public Sector Employment

Our first task is to define the term "public sector employment." Public sector employees can be categorized according to their occupation, their employment status, and who pays their salary. These criteria result in a complex array of cross-cutting public employment categories and many gray definitional areas. Schiavo-Campo *et al.* (1997a, 1997b) point out some problems while defining public sector employment. For example, in some countries teachers and health workers are included in the public sector employment, while in other countries they are not. In some countries, paramilitary personnel are included in the public sector employment because they have a role in maintaining public order, while in other countries they are considered as military

personnel. Moreover, in some countries if the state/regional and local government employees are paid from the central budget then they are still considered as subnational government staff, whereas other countries designate them as central government staff. It is not always clear how different countries define public sector employment, which complicates the comparison of public sector employment across countries. In order to do cross-country comparison of public sector employment, especially at the central government and subnational government levels, we need reliable and comparable data.

The study by Tait and Heller (1984), as we have reviewed in the Chapter Two of this dissertation, represents a beginning in the effort to assemble the statistics for an international comparison of public sector employment and pay. They conducted a survey from 64 International Monetary Fund (IMF hereafter) member countries in 1980. According to them, public sector employment may occur at the central government level, subnational government level and in the nonfinancial public enterprise sector. General government employment is defined to include both central government and subnational government employment. Public sector employment combines employees in the central government, subnational governments and the nonfinancial public enterprise sector.

The main problem in this dataset is the functional category problem. The functional category problem means the vertical distribution variation in public sector employment across countries. For example, in most federal countries, important education, health, police and administrative responsibilities are delegated to the subnational government level. It is meaningless simply to compare the number of central government employees across countries without taking into account that the central government in one country may perform many of the functions that in another country

are performed at the subnational government level. In this respect, their definition may not always be satisfactory. Therefore, we need a sufficiently disaggregated database if our goal is to compare public employment at the central and subnational government levels across countries.

In their paper, Schiavo-Campo *et al.* (1997b) developed a dataset, the *World Bank Public Sector Employment & Wage Dataset*, on central and subnational government employment and wage statistics for almost 100 countries for 1995, including both advanced and less developed countries.[32] In this dataset, education, health, and police employees are excluded from both the central and subnational government employees, and are calculated as a specific category. Most of the data were individually checked and verified with primary sources. As a result, this dataset allows us to examine the comparable data on central and subnational government employment; we believe this dataset to be the most reliable one.

The definition of public sector employment of Schiavo-Campo *et al.* (1997b) is based on the United Nations System of National Accounts,[33] according to which, "general government employees" comprises six mutually exclusive categories:[34]

(1) Armed Forces: covers all enlisted personnel (including conscripts) and professional military. Where possible, administrative employees of the Ministry of Defense have been excluded and are accounted for as civilian central government employees.

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[32] The dataset has been updated. One more period, the year of 2000, has been added in the dataset. The *World Bank Public Sector Employment & Wage Dataset* website is: http://sima-ext.worldbank.org/publicsector/, accessed June 11, 2007. Please refer to Footnote 3 and Appendix B.

[33] Statistical Office of the United Nations, "International Standard Industrial Classification of all Economic Activities, Third Revision," Statistical Papers Series M No. 4, Rev. 3, United Nations, New York, 1990.

[34] For more detail of this definition of public sector employment refer to Schiavo-Campo *et al.* (1997a).

(2) Civilian Central Government (excluding education, health, and police): includes central executive and legislative administration in departments directly dependent on the Head of State or the Parliament, together with all other ministries and administrative departments, including autonomous agencies. Education, health, and police employees paid by central government are accounted for separately.

(3) Subnational Government (excluding education, health, and police): encompasses all government administration employees who are not directly funded by the central government. It includes municipalities, as well as regional, provincial, or state (in federal systems) employment. The distinction between central and subnational government employment is budgetary, not geographic. If central government agencies are geographically dispersed, but without changing their ultimate sources of finance, then the staff in those agencies are included in the central government employees.

(4) Health employees: covers medical and paramedical staff (doctors, nurses, and midwives) and laboratory technicians employed in government hospitals and other government health institutions at all levels of government. Where possible, administrative employees working in the health sector have been excluded and are accounted for as civilian central government or subnational government employees, as appropriate.

(5) Education employees: covers primary and secondary public education employment. Where possible, administrative employees of the Ministry of Education or local school systems have been excluded and are accounted for as civilian central government or subnational government employees, as appropriate.

(6) Police: includes all personnel - whether military, paramilitary or civilian - that exercise police functions. This includes corps like Gendarmerie and Carabinieri. However,

as a matter of convention, it does not include border guards. Police employment data have been included, when readily available, but have not been gathered systematically. If a police number is not available, these data are captured in the civilian central government or subnational government categories.

Total public sector employment comprises general government employment and employment in public enterprises (also called state-owned enterprises) that are majority owned by government. The basic classification of public sector employment can be represented visually as in Figure 2.[35]

Although this dataset is more reliable and better defined, there are only two periods of data so far, the years of 1995 and 2000. With this dataset we have 62 countries covering both periods and 46 countries with only one period. Since this dataset consists of only two periods and some countries only have one period data, we can only do pooling cross-sectional analysis and include a time dummy variable to control for time effect.[36] We use the central government and subnational government employee data in this dataset to investigate the relative change of subnational government employment to central government employment.

Table 1 presents the unweighted average of the central and subnational government employees as a percentage of population for OECD and Non-OECD countries at the years of 1995 and 2000 in our estimation, based on the *World Bank Public Sector Employment & Wage Dataset*. We find that both the unweighted averages of the level of central and subnational government employees for all countries in our

[35] Figure 2 is revised of Figure 1 of the *World Bank Public Sector Employment & Wage Dataset* website: http://www1.worldbank.org/publicsector/civilservice/crosschart.gif, accessed June 11, 2007.
[36] Please refer to Appendix B. After adding in other control variables into the estimation, we have a sample size of 57 observations.

sample grow from 1995 to 2000. The level of central government employees as a percentage of population for OECD countries is 1.81 in 1995 and 2.25 in 2000 while that for non-OECD countries is 1.05 in 1995 and 1.21 in 2000. However, this is not the case of subnational government employment. The average level of subnational government employees as a percentage of population for OECD countries increases from 2.43 in 1995 to 3.01 in 2000 while that for non-OECD countries decreases from 0.74 in 1995 to 0.39 in 2000. Let us turn our attention to take a closer look to the difference in central and subnational government employments between OECD and non-OECD countries. The difference in the level central government employees as a percentage of population between OECD and non-OECD countries is 0.76 in 1995 and 1.04 in 2000. Meanwhile, the difference in the level of subnational government employees is quite significant and the magnitude increases from 1.69 in 1995 to 2.62 in 2000. Figure 3 helps us to visually understand this relative change of central and subnational government employment for OECD and non-OECD countries in these two periods.

Since the determinants of public sector employment are likely to include its domestic, either political or social, conditions, we are not able to capture this individual effect by using a cross-sectional dataset. Therefore, we need a more complete dataset covering more periods, which allows us to perform some econometric models to control for the individual country effects. For our empirical work, we also adopt a dataset from the International Labor Organization (ILO hereafter), or the *International Labor Organization Public Sector Dataset*. The most important international concept of the public sector is contained in the System of National Accounts (Hammouya, 1999).[37] According to which, the public sector is defined as all market or non-market activities

[37] Please refer to Footnote 33.

that are controlled and mainly financed by public authority. Public sector employment comprises employees in the public sector, namely the general government sector and the public corporation sector.

The ILO defines the general government employees as the employees in all government units, social security funds and other nonprofit institutions that are controlled and mainly financed by the public authority. It consists of:

(1) Employees in the government units. The government units carry out government functions, and they include all bodies, departments, and establishments of any level of government (central, state or provincial, local) which engage in administration, defense, maintenance of public order, health, education and cultural, recreational and other social services.

(2) Employees in the social security funds. The social security funds are social insurance schemes covering large proportions or the whole of community, and are imposed, controlled, and financed by government units. They can operate at each level of government.

(3) Employees in the non-profit, non-market public or private institutions. The non-profit institutions are legal entities which are autonomous from government units. They are classified under the general government only if they are non-market, as well as financed and controlled by the public authority.

The public corporation sector comprises all of the institutional units which produce for the market and are controlled and mainly financed by public authority. Public sector employees consist of the employees in the general government sector and the public corporation sector. Figure 4 shows the components of public sector employment

according to the ILO.[38]

The *International Labor Organization Public Sector Dataset* covers 108 countries since 1985.[39] Before 1995, the data are available every five year. Since 1995, the data are available every year. With the property of a panel dataset, we are able to explain the difference of public sector employment across countries by controlling the individual country effect. As we stated above, it does not make much sense to simply compare the number of central government employees across countries without taking into account that the central government in one country may perform many of the functions that in another country are performed at the subnational government level. Our way of dealing with this issue is to use the wider concepts of public sector, namely total public sector employment, as suggested by Marinakis (1994), which makes the cross-country comparisons more homogeneous. That is, we use the total public sector employee data of this dataset as the dependent variable and try to find out what factors might explain the variation of public sector employment across countries and over time.

Table 2 shows the unweighted average of total public sector employees as a percentage of population of OECD and Non-OECD countries of the years of 1985, 1990, 1995, 2000, and 2005 in our estimation, based on the *International Labor Organization Public Sector Dataset*. [40] From this table, we find that the average level of public sector employment for OECD countries is higher than that for non-OECD countries in each period. The average level of public sector employment for OECD countries is quite stable

[38] Figure 4 is a reconstructed version of Hammouya (1999).
[39] The *International Labor Organization Public Sector Dataset* website is http://laborsta.ilo.org/, accessed June 11, 2007. The data have been revised in Appendix A. Please refer to Footnote 2.
[40] For the purpose of comparing the data after 1995 to the data of the years of 1985, 1990, and 1995, we calculate the 5-year average from 1996 to 2000 for the year of 2000. Since the dataset has the public sector data up to 2004, the value of the year of 2005 is calculated by averaging four year data from 2001 to 2004.

over time around 10 employees as a percentage of population but that for non-OECD countries increases over time except for the period 1990-1995, which is 3.55 employees as a percentage of population in 1985 and 7.99 in 2005. We also find that the difference in average level of public sector employment between OECD and non-OECD countries is decreasing over time, which is 7.07 employees as a percentage of population in 1985 and 1.75 in 2005. Figure 5 depicts the time trend of average level of public sector employment for both OECD and non-OECD countries since 1985.

The Definition of Fiscal Decentralization

The second task is to define fiscal decentralization and how we measure it in empirical analysis. Decentralization appears to be so widespread because there is often confusion in the terminology (Martinez-Vazquez & McNab, 1997). Three varieties of fiscal decentralization may be distinguished, corresponding to the degree of independent decision-making exercised at the subnational government level (Bird & Vaillancourt, 1998).

First, what many governments call decentralization is the geographical deconcentration of central government bureaucracy and service delivery. Deconcentration means dispersion of responsibilities within a central government to regional branch offices or subnational administrative units. This process of deconcentration increases effectiveness and flexibility in the delivery of central government services by providing service through regional or local offices of the central government, but it has nothing to do with fiscal decentralization. Under deconcentration, decision-makers in the subnational government level respond to central authorities but not to local constituencies.

The second type of fiscal decentralization is delegation. The process of decentralization by delegation is that the central government gives the subnational governments the power to perform functions and to raise resources according to explicit norms and rules with the understanding that these powers can be changed or revoked by the central authorities. The degree of discretion in providing services and raising tax is often constrained by central government rules. During the process of decentralization by delegation the power remains within the central government. Thus the process of decentralization by delegation may be better identified with unitary forms of government.

The third type of fiscal decentralization is devolution. Decentralization by devolution is a process in which subnational governments have a more permanent right to govern their own affairs with little meddling by the central authorities. In a devolved system, subnational governments have their own-source revenues as well as discretion to determine the mix of services.

The process of fiscal decentralization in our theoretical model, as discussed in Chapter Three, is delegation since the subnational governor has the authority to decide the level of public goods provided in this jurisdiction but the discretion to raise taxes is limited. Now we need to explain how we measure fiscal decentralization. The measure of decentralization used in most of the literature is the subnational share of total government spending/revenue, among which we will use the subnational share of expenditure to measure the degree of fiscal decentralization in the course of this research. Martinez-Vazquez and McNab (2003) and Bird (2000) have noted, among many others, that the subnational share of total expenditures or revenues can be quite misleading. Nevertheless, they use these conventional measures.

Ebel and Yilmaz (2002) examine the accuracy of decentralization studies that use the *Government Finance Statistics Yearbook* (GFS hereafter) of the IMF by comparing these results with those obtained from a more complete OECD dataset. They argue that when using the subnational share of expenditures or revenues in empirical studies on fiscal decentralization, some problems emerge. First, the GFS does not identify the degree of subnational expenditure autonomy. Second, the GFS does not distinguish the sources of tax and non-tax revenue, intergovernmental transfers, and other grants. Third, the GFS does not disclose what proportion of intergovernmental transfers in conditional as opposed to general-purpose, and whether transfers are distributed according to an objective criteria or a discretionary measure. As a result of this limitation, the standard measure of decentralization ends up being an overestimate of fiscal decentralization and is far from being a perfect measure.

In spite of this, the GFS offers a wide range of data on expenditures and revenues by function and economic type at all levels of government. Moreover, the GFS dataset goes as far back as 1970 for some countries and also offers data for many developing countries. In contrast, the OECD dataset suggested by Ebel and Yilmaz (2002) includes only six countries and information for a period of only three years (1997-1999).[41] Internationally comparable data that provide this kind of information are not available from other sources. Therefore, the GFS still constitutes the best source of data across countries, and the subnational share of expenditure/revenue, despite its acknowledged limitations, is still the best available measure of fiscal decentralization.

In this study, we measure fiscal decentralization as the subnational share of public expenditure because we think the subnational share of revenue collection is not as good

[41] These six countries are Czech Republic, Estonia, Hungary, Latvia, Lithuania, and Poland.

an indicator. In most developing countries, for example, China, some tax revenues are levied by the central government but mainly collected by the subnational government. As a result, locally collected revenues are not allocated by the subnational governors and the share of subnational government revenue over total revenue does not reflect the tax autonomy of subnational governors (Zhang & Zou, 1998). In addition, according to our theoretical model developed in Chapter Three, we use the share of subnational government expenditure to explain the variation of public sector employment. Therefore, the subnational government share of public expenditure is an appropriate measure of fiscal decentralization in the context of our model. Taking these into account, we focus on the expenditure side of fiscal decentralization, instead of the revenue side.

Table 3 is the unweighted average of subnational government shares of public expenditure for OECD and Non-OECD countries of the years we use in our estimation. We find that the average of subnational shares of expenditure for OECD countries is higher than that for non-OECD countries in each period. The average of subnational shares of total public expenditure for OECD countries in these five periods is 31.14%, while that for non-OECD countries is 18.52%. The difference in subnational shares of public expenditure between OECD and non-OECD countries is 12.34 percentage points in 1985 and 16.74 in 2005. Figure 6 depicts the time trend of average of subnational government share of public expenditure for both OECD and non-OECD countries since 1985.

The Empirical Hypotheses

The main purpose of this study is to analyze how fiscal decentralization policy

affects the composition of the public sector employment, focusing on two of the most important categories: central and subnational government employment. In particular, we also want to find out the determinants of total public sector employment. We restate the predictions of our theoretical model as follows:

Hypothesis One: There is a positive relationship between the degree of fiscal decentralization and the subnational government employment. With a higher degree of decentralization, the central government allocates more national resources to the subnational level, which releases the subnational government budget constraint and induces the subnational governor to hire more subnational government employees. We use the *World Bank Public Sector Employment & Wage Dataset* to test this hypothesis since this dataset helps us to overcome the functional category problem, and therefore, the data of the level of central government or subnational government employees as a percentage of population of different countries are more reliable and comparable.

Hypothesis Two: The effect of fiscal decentralization on total public sector employees depends on the magnitudes of two opposing effects: one is the reduction in central government employment and the other one is the increase in subnational government employment. If the amount of the reduction in central government employment overwhelms the increase in the subnational government employment, total public sector employment decreases with the degree of fiscal decentralization. This is on line with the Brennan and Buchanan's (1980) Leviathan hypothesis if we measure the government size as total public sector employees as a percentage of population. Most studies of Leviathan hypothesis have focused on the growth of the share of government expenditure as a share of GDP. However, growth in the public sector employees might

constitute an equally valid alternative test of this hypothesis. In short, the Leviathan model implies that the size of the public sector should vary inversely with the extent of fiscal decentralization, other things being equal.

On the other hand, if the amount of the increase in the subnational government employment overwhelms the reduction in the central government employment, total public sector employment increases with the degree of fiscal decentralization. If this is the case, we would support Oates (1972, 1985) and Wallis'[42] point of view that the public sector tends to be larger with more fiscal decentralization. We use the *International Labor Organization Public Sector Dataset* to test this hypothesis, since this dataset has more observations at cross-sectional and over-time dimensions. Moreover, there is no functional category problem while comparing the level of total public sector employees across countries and over time.

Hypothesis Three: We predict that the level of GDP per capita of a country is positively correlated to the level of its subnational government employees. Given a fixed tax rate, with a higher level of GDP per capita, the subnational governor has more resources from the central government, which allows the subnational governor to hire more employees, other things being equal. Hypothesis Three is in line with Wagner's law, which argues that economics development creates demand for new types of government services, and the government sector needs more public employees to provide these services. However, based on our theoretical model, this positive correlation does not exist between GDP and central government employment. Consequently, the overall impact of GDP on total public sector employment can not be determined a priori. We use both the *International Labor Organization Public Sector Dataset* and *World Bank Public Sector*

[42] Wallis' argument has been cited in Oates (1985).

Employment & Wage Dataset to test this hypothesis.

Hypothesis Four: We predict that the level of subnational government employees increases with the proportion of political cost caused by negative subnational governmental budget gap that is shifted to the central government, σ.[43] If the subnational governor is able to shift the political cost of negative subnational budget gap to the central executive easily, he is likely to hire more public employees to increase their utility and ask the central government executive to pay part of the bill. In this case, the central government executive has to transfer a larger proportion of resource to the subnational governments to reduce the political cost of the negative subnational budget gaps. This way reduces the public employees at the central government level. The impact of this political variable on total public sector employment is ambiguous, due to these two opposing effects. We use the *World Bank Public Sector Employment & Wage Dataset* to test the impact of the political variable on the relative change of public employment at the central and subnational governments. Then we use the *International Labor Organization Public Sector Dataset* to test the impact of this political variable on total public sector employment.

The Political Variables

In our theoretical model, we introduce a political variable, σ, to measure the ability of the subnational government to shift the political cost of the negative budget gap occurred at the subnational government to the central government. The higher the value of σ, the higher the ability of the subnational government to shift the political cost to the

[43] We will discuss how we measure the ability of subnational governors to shift the political cost of subnational government deficit to the central government in the next section.

central government. In Chapter Three, we present an example that in some countries, like Greece and Hungary, subnational governments do not have autonomous power in taxing or spending and we expect that such subnational governors act like the agent of the central executive. Therefore, the subnational governors in such countries can easily shift its political cost of negative budget gap to the central government and bear less part of political cost. On the other hand, the subnational governors in the other countries where they have more autonomy in subnational government finance have to bear larger part of political cost of the negative subnational government budget gap. As a result, we expect that the level of subnational government employees of a country whose subnational governors have more taxing and spending autonomy power is lower than that of a country whose subnational governors have less taxing and spending autonomy power.

Empirically, there are no variable indicating the ability of the subnational government to shift the political cost of the budget deficit occurred at the subnational government to the central government executive. However, in the *Database of Political Institutions* (DPI hereafter) of the World Bank, we find data that are able to capture the autonomy power of the subnational governors.[44] These data are represented by a dummy variable, with a value equals to one if the state/provinces have authority over taxing, spending or legislating and zero otherwise. The DPI covers most countries from 1975 to 2004. However, since this dataset only has 38% non-blank observations and it might not be easy to simply divide countries into two groups, countries whose local governors have autonomy over taxing, spending and legislating and countries whose local governors do not have such autonomy, such a variable is not suitable for empirical analysis. In addition,

[44] This dataset is available online at http://econ.worldbank.org/WBSITE/EXTERNAL/EXTDEC/EXTRESEARCH/0,,contentMDK:20649465~pagePK:64214825~piPK:64214943~theSitePK:469382,00.html, accessed June 11, 2007.

taxing, spending and legislating are three very different things. It would be very desirable to capture them with separate dummy variables. Moreover, an autonomy power is always a matter of degree and not a matter of a closed question with a yes or a no answer. Therefore, a simple dichotomy might be misleading.

Our solution to this shortcoming is to find a proxy variable to measure the degree of autonomous power. We use the local election variable from the DPI to deal with this issue. If a subnational governor is elected by local constituents, then we expect him to have more autonomy power and more responsibility to the local public finance. Therefore, if a negative subnational budget gap occurs in this jurisdiction, the locally elected governor has to bear relatively greater part of the penalty from the negative budget gap. This implies that we expect the level of subnational government employees of a country which subnational governors are locally elected to be lower than that of a country which subnational governors are appointed by the central government.

Based on the definition of DPI, the value of this variable equals zero if neither subnational governor nor subnational legislature are locally elected, one if the subnational governor is appointed but the legislature is elected, and two if both are locally elected. The higher the value of this political dummy variable, the greater the responsibility of the subnational governor to the subnational public finance is. Since the subnational governor is more responsible to the subnational public finance, he will try to lower the negative subnational budget gap as possible as he could, and, therefore, the level of subnational government employment will be lower. This implies that we expect that the subnational government employment level decreases with the value of this political dummy variable.

Our second political variable is also a dummy variable, which defines the

constitutional relationship between the central and subnational governments of a country. All the countries can be categorized into two groups: unitary and federal states. A unitary state is a country which political power mainly controlled by the central government and could be transferred or "delegated" to subnational government units. The central government retains the principal right to recall such delegated power. Moreover, any subnational government units in a unitary country can be created or abolished. As a result, we expect that the central government in a unitary country controls over relatively more resources of the country and provides relatively more public services to its residence than that in a federal state.

Empirically, we expect that the level of central government employees in a unitary country is higher than that in a federal. This dummy variable equals one if the country is a unitary state and zero if it is a federal state.[45]

The Empirical Issues

Estimated Equations

First, we want to know what factors cause the relative change of public sector employment at subnational government level to central government level. That is, we want to test the impact of fiscal decentralization, real GDP and the ability of the subnational government to shift the political cost of negative subnational budget gap on both the central and subnational government employments. To do this, we use the *World Bank Public Sector Employment & Wage Dataset* to estimate the System of Equations

[45] The list of unitary states is available online at http://en.wikipedia.org/wiki/Unitary_state, accessed June 11, 2007. Note that in many other issues of classification, this way can be misleading. For example, Spain is a unitary country formally, but in practice, it operates more like federation than many formal federations.

(14):

$$\begin{cases} CGE_i = \beta_{10} + \beta_{11} \cdot UNI_i + \beta_{12} \cdot W_i + \beta_{13} \cdot YEAR_i + \varepsilon_{i,1} \\ SGE_i = \beta_{20} + \beta_{21} \cdot DEC_i + \beta_{22} \cdot ELE_i + \beta_{23} \cdot W_i + \beta_{24} \cdot YEAR_i + \varepsilon_{i,2} \end{cases} \quad (14)$$

where the dependent variables CGE_i and SGE_i are the level of central and subnational government employees as a percentage of population in country i respectively.[46] The variable DEC_i is a measure of the degree of fiscal decentralization, defined as the subnational government share of public expenditure, in country i. UNI_i is a dummy variable, which equals one if this country is a unitary country and zero if this country is a federal country. ELE_i, a dummy variable with three values, 0, 1 and 2, is to measure the responsibility of the subnational governor for subnational public finance. A country with a higher value of ELE_i means that the subnational governor in that country is more responsible to subnational public finance than the subnational governor in a country with a lower value of ELE_i. W_i is a set of control variables which are standard in the Leviathan literature, including a dummy for OECD countries, GDP per capita and the degree of urbanization. We also include an index for openness, measured as the sum of exports and imports of goods and services as a share of GDP, as suggested by Rodrik (1996). Finally, we put the time dummy variable, $YEAR_i$, in our estimation model to control for time effect, which equals one if the data is observed for the year of 2000 and zero for the year of 1995.

In our theoretical model, since the degree of fiscal decentralization and central government employment are jointly determined by the central executive, we should not

[46] We will explain why we use the level of government employees as a percentage of population as our dependent variable in the next section.

include the fiscal decentralization variable, DEC_i, in the first estimating equation of the System of Equations (14) to avoid the endogeneity problem.[47] Table 4 lists the definitions of all variables in our model.

According to Hypothesis One, we expect the sign of the coefficient of fiscal decentralization on subnational government employees, β_{21}, to be positive. According to Hypothesis Four, we expect the coefficient of the political variable, UNI_i, to be positive in the first estimation equation and the coefficient of the political variables, ELE_i, to be negative in the second equation of the System of Equations (14).

Second, we use the *International Labor Organization Public Sector Dataset* to test the impact of fiscal decentralization, GDP, and the political variable on total public sector employment by estimating Equation (15):

$$PSE_{i,t} = \beta_0 + \beta_1 \cdot DEC_{i,t} + \beta_2 \cdot UNI_{i,t} + \beta_3 \cdot ELE_{i,t} + \beta_4 \cdot W_{i,t} + a_i + \varepsilon_{i,t} \qquad (15)$$

where the dependent variable, $PSE_{i,t}$, is the level of total public sector employees as a percentage of population in country i in year t. The independent variables, $DEC_{i,t}$, measures the degree of fiscal decentralization in country i in year t; $UNI_{i,t}$ and $ELE_{i,t}$ are two political variables and $W_{i,t}$ is a set of control variables as we described above. a_i is the unobserved country effect, which can be thought of as omitted variables and is time invariant within a country. Since the number of time periods is small relative to the number of observation, we could include a dummy variable for each time period to

[47] We also suspect that the variables, subnational government employment, SGE, and degree of fiscal decentralization, DEC, are likely to be simultaneously related, and we conduct the endogeneity test for DEC before we estimate the System of Equations (14). We will discuss the endogeneity test later in this chapter.

account for secular changes that are not modeled.[48]

Brennan and Buchanan's Leviathan hypothesis argues that the size of the public sector should vary inversely with the extent of fiscal decentralization, other things being equal, which implies the sign of the coefficient on $DEC_{i,t}$, or β_1, to be negative.[49] However, according to Oates and Wallis' argument, the sign of β_1 is expected to be positive.

Wagner's law argues that economic development creates demand for new types of government services, which derives the public sector to hire more employees to provide these services. Consequently, Wagner's law expects the sign of coefficient of GDP per capita in our control variable $W_{i,t}$ to be positive. However, our theoretical model only shows that GDP per capita is positively correlated with the subnational government employment level but not central government employment level.

In addition, according to Kraay and van Rijckeghem (1995), we expect government employment to be positively associated with the degree of urbanization, since urbanization stimulates the demand for certain public services, which drives the public sector to increase government employees. Moreover, according to Rodrik (1997), the level of government employees increases with exposure to external risk since relatively safe government jobs represent partial insurance against risk faced by the domestic economy.

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[48] See, for example, Wooldridge (2000).

[49] Most empirical studies that test for Brennan and Buchanan's Leviathan hypothesis, as we discuss in Chapter Two, measure the size of the public sector as the share of public expenditure on GDP, for example, Oates (1985), Nelson (1987), Zax (1989), and Forbes and Zampelli (1989).

Description of the Data

To test our four hypotheses, we use two datasets: one is the *World Bank Public Sector Employment & Wage Dataset*, which is an unbalanced panel dataset of 108 countries covering either the year of 1995 or 2000 or both,[50] and the other one is the *International Labor Organization Public Sector Dataset*, which is also an unbalanced panel dataset covering 111 countries with the years of 1985, 1990, 1995, 2000, and 2005.[51] The data of fiscal decentralization are extracted from the *Government Finance Statistics Yearbook* of the IMF for these years, which is defined as the subnational government expenditure share of total public expenditure. The *World Development Indicators* (WDI, 2005) is the source for the control variables including GDP per capita, the degree of urbanization and the index of openness. Table 4 lists each variable with its label, definition, and units of measurement. Table 5 presents the descriptive statistics of the variables used on the empirical estimation of the System of Equations (14). Table 6 shows the descriptive statistics of the variables used on the empirical estimation of estimation Equation (15).

Specification Issues of the Dependent Variables

In our theoretical model, we derive the relationship between public sector employees and GDP. In practice, we divide both variables by population of the country. That is, our dependent variable is the number of public sector employees as a percentage of population and our independent variable that represents economic growth is GDP per

[50] However, due to the limitation of other variables, the subnational government expenditure share and local election variable, we only have a sample size of 57 observations in our estimation.
[51] Again, after combining other independent variables, we have 41 countries covering various years. The sample size for this estimation is 108.

capita, which is used in almost all empirical studies, such as Tait and Heller (1984), Kraay and van Rijckeghem (1995), Schiavo-Campo *et al.* (1997b) and Rama (1997).

In order to control the demographic characteristics of countries, we also use the number of public employees as a percentage of labor force as the dependent variable, which is used in Rama's (1997) cross-country study and Marques-Sevillano and Rossello-Villallonga's (2004) case study on Spain.

Econometric Issues Related to Estimation of System of Equations (14)

Seemingly Unrelated Regression Model: In this section, we will introduce the econometric methodology which we have applied to estimate our System of Equations (14). Our goal is to find out the impact of the degree of fiscal decentralization and GDP on subnational government employees as well as the impact of the ability of the subnational governor to shift the political cost of negative subnational budget gap to the central government executive on both central and subnational government employment. We have two regression equations of interest in the System of Equations (14). However, if we run the regression for each equation separately, we might find that the error terms of each equation are correlated to each other. For example, if there are some factors that affect both the dependent variables and are not in our control variables, we expect that the error terms from these two regressions might be correlated.

In order to control for this, we employ the Seemingly Unrelated Regression (SUR hereafter) model, proposed by Zellner (1962).[52] The SUR model permits nonzero covariance between the error terms $\varepsilon_{i,1}$ and $\varepsilon_{i,2}$ for a given individual country i across

[52] For more detail discussion on SUR model, please refer to Appendix C or Section 15.4 of Greene (2000).

equations of the System of Equations (14), while assuming $Cov(\varepsilon_{i,1}, \varepsilon_{i',2}) = 0$, where i' represents any country other than country i. These two assumptions seem reasonable in real world. For example, the effect of fiscal decentralization on the central government employment in the United States affects that on the subnational government employment in the United States; however, the effect of fiscal decentralization on the central government employment in the United States is uncorrelated with that in China. This potential nonzero covariance across these two equations allows for an improvement in efficiency of the SUR model estimator relative to the OLS estimator. Moreover, the greater the correlation of the residuals, the greater the efficiency gain accruing to SUR model.

We report the estimation result of the System of Equations (14) by using SUR model in the first two columns of Table 7. In addition, in order to illustrate the efficiency gains of SUR model relative to OLS model, we report the OLS estimation result in the next two columns of Table 7. We report the robust z-statistics of OLS estimators, which are valid in the presence of heteroskedasticity in an unknown form.

Endogenous Variable: As we have mentioned above that the dependent variable of the second equation of the System of Equations (14), $SGE_{i,t}$, and the dependent variable, $DEC_{i,t}$, are likely to be simultaneously correlated, we might have the endogeneity problem in our estimation of the System of Equations (14). This endogeneity problem arises from the correlation between the degree of fiscal decentralization and the error term. If the endogeneity problem exists in our estimation model, then the estimators will be biased. Thus, before we add this potential endogenous variable, the degree of fiscal decentralization, in the model, we need to conduct an endogeneity test for it. Our

endogeneity test follows the regression-based approach introduced by Wooldridge (2002).

To conduct the endogeneity test, we need to find a set of suitable instrument variables (IV hereafter) for this potential endogenous variable. A suitable IV must be uncorrelated with the error term and correlated with the endogenous variable in the model. According to Panizza (1999), the degree of fiscal centralization is negatively correlated with ethnic fractionalization. Empirically, three fractionalization indices are often used. Besides ethnic fractionalization, there are linguistic and religious fractionalization indices (Alesina *et al*., 2003). The fractionalization index is measured by the probability of two randomly chosen individuals belonging to different groups and can be shown as:

$$Fractionalization\ Index = 1 - \sum_{i=1}^{N} \left(\frac{POP_i}{POP_T}\right)$$

where POP_N is total population and POP_i is the number of people belonging to group *i*. In our estimation, we use these three fractionalization indices as the IVs to test the endogeneity of fiscal decentralization.

We start by estimating the reduced form of fiscal decentralization level using all other independent variables in the estimation of the second equation of the System of Equations (14) and three IVs as the independent variables. We obtain the residuals from this estimation and then run the regression of our dependent variable in the estimation of the second equation of the System of Equations (14) on all independent variables in the equation as well as the residuals from the estimation of the reduced form equation. The robust *t*-statistic of estimated coefficient of this error term is 1.45, with the corresponding *p*-value of 0.15. This result implies that we are not able to reject the null that the coefficient is zero at the conventional significance level. The insignificance of this coefficient implies that the degree of fiscal decentralization is not an endogenous variable

in our estimation model and, therefore, our estimators are unbiased.[53]

Heteroskedasticity: If the residuals from the OLS or pooled OLS regression model are not homoskedastic, or $Var(u_i) \neq \sigma^2$, the estimators are unbiased and consistent but inefficient. In the presence of heteroskedasticity, the OLS standard errors are no longer valid for constructing confidence intervals and t statistics.

In our empirical work, we employ the White test to detect the heteroskedasticity.[54] We conduct the White test for heteroskedasticity for each equation of the System of Equations (14). The White's test statistic for the first equation in the system of equation (14) is 52.80 with *p*-value of 0.33 and 33.00 with *p*-value of 0.42 for the second equation. The result fails to reject the null hypothesis of homoskedasticity assumption and, therefore, we conclude that our empirical model of the System of Equations (14) satisfies the homoskedasticity assumption.

Econometric Issues Related to the Estimation of Equation (15)

Endogenous Variable: Our estimation of Equation (15) is based on the equation of $m^* = m_c^* + n \cdot m_i^*(\theta^*, \sigma, n, \overline{R})$. Since m_c^* and θ^* are jointly determined by the central government executive and m^* consists of m_c^* and $n \cdot m_i^*$, there might be an endogeneity problem in the regression model of m^* on θ^*.

As we have mentioned in the case of the estimation of the System of Equations (14), if there is an endogeneity problem in our estimation model, we would get biased estimated coefficients. We conduct an endogeneity test for the indendent variable, degree

[53] Please see Wooldridge (2002), Section 6.2, p118.
[54] We have included more detail discussion of the heteroskedasticity test in Appendix D of this dissertation.

of fiscal decentralization, which procedure is the same as what we have done for the estimation of the second equation of the System of Equations (14). The robust *t*-statistic of estimated coefficient of the error term from the estimation of the reduced form of fiscal decentralization is 1.38 and we are not able to reject the null that the coefficient is zero at the conventional significance level. The insignificance of this coefficient implies that the degree of fiscal decentralization is not an endogenous variable in our estimation model and, therefore, our estimators are unbiased.

Heteroskedasticity: Heteroskedasticity might be a problem in our estimation of Equation (15), as we have discussed in the estimation of the System of Equations (14). We pool our panel dataset and conduct the White's test for heteroskedasticity. The White's test statistic is 93.72 and the corresponding *p*-value is 0.01. The result rejects the null hypothesis that the residuals are homoskedastic. Therefore, we have heteroskedasticity problem while estimating the Equation (15). In this case, our estimators are still unbiased on consistent but inefficient. Moreover, the normal standard errors are invalid for constructing confidence intervals and *t*-statistics. As a result, we need to use the robust standard errors for conducting the statistical inference since they are valid in the presence of any heteroskedasticity.

Individual Effects: Consider our estimation of Equation (15):

$$PSE_{i,t} = \beta_0 + \beta_1 \cdot DEC_{i,t} + \beta_2 \cdot UNI_{i,t} + \beta_3 \cdot ELE_{i,t} + \beta_4 \cdot W_{i,t} + a_i + \varepsilon_{i,t} \quad (15)$$

where a_i are sometimes called an individual effect or individual heterogeneity, and the $\varepsilon_{i,t}$ are called the idiosyncratic errors. For simplicity, we rewrite Equation (15) as:

$$y_{i,t} = X_{i,t} \cdot \beta + u_{i,t} \quad (16)$$

where $y_{i,t}$ is our dependent variable, the level of public sector employees as a percentage

of population of country i at time t and $X_{i,t}$ includes a constant term and all our dependent variables of country i at time t. $u_{i,t} \equiv a_i + \varepsilon_{i,t}$ are the composite errors. Under the assumption that there is no correlation between $X_{i,t}$ and $u_{i,t}$, the pooled OLS estimator can be used to obtain a consistent estimator of β in estimation of Equation (16). Ignoring the individual effects, the pooled OLS estimator is biased and inconsistent if the individual effects are correlated with the dependent variables. If the individual effects are uncorrelated with our dependent variables, ignoring the individual effects and applying pooled OLS, the estimator might still be inefficient. This is because the composite errors might be serially correlated due to the presence of individual effects in each time period.[55] In our study, we apply fixed effects and random effects approaches to control for the individual effects.

The decision of applying fixed effects model or random effects model depends on whether or not the individual effects are correlated with our independent variables. The random effects model assumes the individual effects are uncorrelated with the independent variables. Hausman (1978) devises a specification test which can be used to test the correlation of the individual effects and the independent variables, as we will discuss in the following context.

Serial Correlation: To estimate Equation (15), we use the total public sector employment data from the *International Labor Organization Public Sector Dataset*. In the dataset, we have five periods, with each period covering 5 years.[56] Since the data we use in our regression model covers for 25 years, we suspect that serial correlation might

[55] For more detail discussion of this part, please refer to Wooldridge (2002) Section 10.3.
[56] Note that the data of the year 2005 covers only from the year 2000 to 2004.

be a problem. If we ignore serial correlation and estimate the variance in the usual way, the variance estimator will usually be biased when the parameter of the serial correlation is not equal to zero.

The estimate of the first-order serial correlation, or AR(1), parameter, ρ, is obtained by running the regression of $u_{i,t}$ on $u_{i,t-1}$ without a constant. For each country i, we lose the first observation, that is, $t = 2,3,...,T$. The estimated serial correlation coefficient, $\hat{\rho}$, is 0.275 with the robust *t*-statistics of 1.56 for our fixed effects and random effects model. The insignificance of the serial correlation coefficient implies that there is no serial correlation problem in our estimation model.

Testing Individual Effects versus Pooled OLS: As we have indicated before that ignoring the individual effects, the pooled OLS estimator is biased and inconsistent if the individual effects are correlated with the dependent variables. Under the assumption of the individual effects being jointly equal to zero, the pooled OLS estimator is the best linear unbiased estimator. Breusch and Pagan (1979) have derived a statistic using the Lagrange multiplier in a likelihood setting to test the presence of individual effects, or called the *LM* test. The null hypothesis of the absence of individual effects, statistically equivalent to $H_0 : \sigma_a^2 = 0$, is against the alternative hypothesis of the presence of individual effects, or $H_1 : \sigma_a^2 \neq 0$. Based on the residuals from the OLS estimation of Equation (15), we obtain a Lagrange multiplier test statistic of 60.68, which far exceeds the 99% critical value of chi-squared with one degree of freedom, 3.84. As a result, we concluded that the pooled OLS regression model with a single constant term is

inappropriate for our data.[57]

Testing Fixed Effects versus Random Effects Estimators: The distinction between fixed and random effects models is the assumption whether or not the individual effects are correlated with the independent variables. Hausman (1978) test, based on the difference between the random effects and fixed effects estimates, can be used to test the correlation between the individual effects and the independent variables. Under the null hypothesis of no correlation, both fixed effects and random effects estimates are consistent, but fixed effects estimate is inefficient, whereas under the alternative hypothesis, the fixed effects estimate is consistent, but the random effects estimate is not.

The Hausman statistic of our data is 33.06 and the corresponding *p*-value is closed to zero. This result rejects the null hypothesis of no correlation between the individual effects and independent variables, which implies that the random effects estimate is not consistent and fixed effects model is appropriate. Based on the *LM* test, which is decisive that there are individual effects, and the Hausman test, which suggest that these effects are correlated with the other variables in the model, we would conclude that of these two alternatives we have considered, the fixed effects model is the better choice. However, we still report both results for comparison purposes.[58]

The Generalized Method of Moments (GMM) Estimation: Besides the fixed effects and random effects model estimation as discussed before, in this dissertation we also employ the GMM method to estimate Equation (15).[59] The intuition of GMM is to use the moment conditions that are assumed to be satisfied to minimize the GMM objective function. Thus, we need to assume that the moment condition $E(X'u) = 0$ in

[57] For more detail of this test, please refer to Appendix F.
[58] See Appendix G for more discussion of Hausman test.
[59] For more detail discussion on the GMM approach, refer to Appendix H of this dissertation.

Equation (16) is satisfied. In testing for the endogeneity of variable the degree of fiscal decentralization, we have a set of three additional exogenous variables. Let Z be the set of our exogenous variables, including the independent variables in Equation (16) and three fractionalization index variables. Consequently, our moment condition can be rewritten as $E(Z'u) = 0$.

Under the condition that there are no endogenous regressors in our regression model and we have additional moment conditions, our efficient GMM estimator is that of Cragg's heteroskedasticity OLS. This estimator is more efficient than OLS in the presence of heteroskedasticity of unknown form and the efficiency gains drive from the additional moment conditions (Davidson & MacKinnon, 1992). We report our GMM estimation results in the third column of Table 8 and Table 9.

Spatial Dependency Tests: As indicated in Chapter One, policy makers may be affected by neighboring country's policies when they make their own policies due to the presence of spatial effects. Spatial autocorrelation tests, as we introduce here, are used to measure the degree of dependence among observations in a given geographic space. Currently, several statistics measuring the extent of spatial autocorrelation are available; among these, Moran's *I* and Getis and Ord's *G* statistic are the most commonly used statistics (Florax & van der Vlist, 2003).[60] In this dissertation, we use these two statistics to detect the spatial effects in our dataset.

Before conducting the spatial dependency test, we need to define an appropriate weight matrix to quantify the structure of spatial dependence between observations. We category all the countries in our dataset into six groups: Africa, Asia, Eastern Europe and

[60] See Appendix I for more detail about these two spatial dependency tests.

former Soviet Union, Latin America and the Caribbean, the Middle East and North Africa, and OECD. Due to the similarities in political and social-economic background of countries within each group, we expect that spatial effects are more likely to exist within groups than between groups. Based on this spatial configuration, our spatial weight matrix, *M*, takes the form:

$$M = \begin{bmatrix} 0 & \cdots & M_{1n} \\ \vdots & \ddots & \vdots \\ M_{n1} & \cdots & 0 \end{bmatrix},$$

where *n* is the number of observations. All the elements of the diagonal of *M* are zero. $M_{ij} = 1$, $\forall i \neq j$, if country *i* and country *j* are in the same group; otherwise, $M_{ij} = 0$.

The Moran's *I* statistic for our sample is 17.14; meanwhile, the Getis and Ord's *G* statistic is 5.13. Both statistics are significant at 1% significance level. This result implies that spatial effects within groups are significantly present. This also confirms both previous cross country spatial analysis studies of Redoano (2003) and (Mbakile-Moloi (2006).

Estimation Results

Estimation Results of the System of Equations (14)

In this section we present our estimation results of the System of Equations (14). The first two columns in Table 7 show the regression results for the System of Equations (14) by applying the SUR estimation. As indicated before, the efficiency gains of SUR estimation over OLS estimation comes from allowing the nonzero covariance between residuals from both equations. To illustrate this, we also report the estimation result by using OLS and put these two results together for easy comparison. The correlation of the

residuals from two equations in the System of Equations (14) is 0.12.

The purpose of the estimation of the System of Equation (14) is to find out how fiscal decentralization policy and the political variables influence the relative change in subnational government employment compared to the change in central government employment. From Table 7 we can see that the coefficient on fiscal decentralization is positive at 1% significance level. The significant positive result implies that the level of subantional government employees as a percentage of population increases with the degree of fiscal decentralization, other things being equal. As we have stated in the previous chapter, a higher degree of fiscal decentralization means that more resources go to the subnational government, which allows the subnational governor to hire more employees. This finding confirms Wallis's[61] hypothesis that the subnational government tends to be larger with the extent of fiscal decentralization since individuals with more control over public decisions at the subnational level than at the national level may empower the subnational governments with more responsibilities and functions. This result also confirms Marques-Sevillano and Rossello-Villallonga's (2004) study of the Spanish case. They find that in Spanish economy the regional governments that have received larger degrees of responsibilities from the central government are the ones that have higher levels of public employees during the period 1990-1999.

For the political variables, we expect that the level of central government employees is higher in a unitary country. This is because the central government in a unitary country has direct authority over the subnational governments and control over most resource of the country, which allows the central executive to hire more public employees. We also predict that the level of subnational government employees is lower

[61] Wallis' argument has been cited in Oates (1985).

in a country which subnational governors are elected by local residences. This is because the subnational governor who are elected locally are more responsible to the subnational public finance and have to bear greater proportion of the cost of the negative subnational government budget gaps than the governors who are appointed by the central government since they can easily shift the cost to the central executive. As a result, the elected subnational governors do not allow a negative budget gap to occur or seek to lower the gap. Based on this argument, we expect that the level of subnational government employees is lower in a country which subnational governors are elected. To sum up, the level of public employees at the central government level tends to be higher in a unitary constitutional system; on the contrary, the level of public employees at the subnational government level is lower in the countries which subnational governors are elected locally.

Our SUR estimation of the coefficients of these political variables in the System of Equations (14) shows that the level of central government employees in a unitary state indeed is higher than that in a federal country by 0.86 employees per 100 people at 1% significant level. This result confirms our prediction that a unitary country has higher level of central government employees than a federal country does. Our result also shows that the level of subnational government employees is lower in a country which both subnational governors and legislatures are elected than that in a country which the subnational governors are appointed but the legislatures are elected by 0.9 employees per 100 people. This amount doubles when we compare to a country which both subnational governors and legislatures are appointed by the central government, other things being equal.

Among the other control variables, we find that the level of GDP per capita is positively correlated to both the levels of central government and subnational government employees as a percentage of population at 1% significant level, which confirms Wagner's law that economic development creates demand for new types of government services. We also find that the level of central government employees tends to be higher in a more opened country. The openness of a country is defined as the ratio of the sum of the country's imports and exports of goods and services on GDP. This finding confirms Rodrik's (1996, 1997) and Rama's (1997) arguments that relatively safe government jobs represent partial insurance against undiversifiable external risk faced by the domestic economy.

By comparing the estimation results of SUR approach to OLS approach, we find that these two results are quite the same, except for the significance level. Our estimation result of the System of Equations (14) tells us that the level of subnational government employees as a percentage of population increase with the degree of fiscal decentralization and tend to be lower in the country which both subnational governors and legislatures are elected while the level of central government employees as a percentage of population is higher in unitary countries. As we have stated in Chapter One, the variation of public sector employment could be defined in three dimensions: time series, cross section, and structural dimensions. The estimation of the System of Equations (14) explains what factors might have caused the structural change of public sector employment. In the next section, we will discuss the empirical results that explain the variation of public sector employment in time series and cross section dimensions.

Estimation Results of the Equations (15)

Table 8 and Table 9 list our estimation results of Equation (15). The dependent variable in Table 8 is the level of public sector employees as a percentage of population. Since the demographic characteristics might vary across countries, in order to control over this, we also estimate the determinant of the level of public sector employees as a percentage of labor force and report the result in Table 9. The first and second columns in Table 8 and Table 9 are the estimation results by applying fixed effects and random effects approaches respectively. The third column is the estimation result by employing the GMM approach. The quantity in parenthesis is the absolute value of robust z-statistics, which is valid in the presence of heteroskedasticity and serial correlation in unknown form.

First, we discuss the results of fixed effects and random effects models. The Hausman test helps us choose the appropriate model from fixed effects and random effects models. The Hausman statistic of our data is 33.06, which corresponding *p*-value is closed to zero. Thus, we reject the null hypothesis of no correlation between the individual effects and other independent variables in the model, which indicates that the random effects estimate is inconsistent and the fixed effects model is the better choice. In the following discussion, we will focus on the fixed effects model.

Our Hypothesis Two suggests that fiscal decentralization plays an important role in the determination of total public sector employment but our theoretical model does not give us an explicit relationship between these two variables since it depends on two opposing effects. From our fixed effects model estimation, we are not able to conclude whether fiscal decentralization is positively or negatively related to the level of total

public sector employees as a percentage of population. Except for the coefficients of the time dummies, the only significant coefficient in fixed effects model is that on local election. However, this coefficient is not significant in the other two models.

As we have mentioned previously, our GMM estimation is more efficient due to three additional moment conditions. Indeed, our GMM estimators are more significant than fixed effects estimators, referring to the Table 8 and Table 9. The GMM estimation result shows that the degree of fiscal decentralization has a positive and significant effect on the level of public employees as a percentage of population at 5% significance level, as reported in Table 8. The magnitude of this coefficient is 0.141, which implies that a ten percentage point increase in the subnational government share of public expenditure results in an increase of 1.41 public employees, all else being equal. This finding supports the argument of Oates (1972, 1985) and Wallis[62] but based on different explanations. Oates (1972, 1985) argues that highly decentralization may lose certain economies of scale which makes the public sector have to increase the employee level. Wallis argues that in a highly decentralized government, individuals have more control over public decisions at the subnational government level than at the central government level, and they will wish to empower the public sector with a wider range of functions and responsibilities carried out at more localized levels of government. In our theoretical model, we predict that fiscal decentralization policy drives the increase in the subnational government employment and restrains the growth of central government employment. Our empirical result shows that the magnitude of the increase in the subnational government employment is greater than that of the reduction in the central government employment. As a result, total pubic sector employment increases with the degree of

[62] Wallis' argument has been cited in Oates (1985).

fiscal decentralization.

We turn our attention to the coefficient on GDP per capita, which is insignificant. Based on our theoretical model, we expected that the subnational government employment increases with GDP but the central government employment might increase or decrease with it. From the estimation result of the System of Equations (14), we know that both the levels of central and subnational government employees as a percentage of population increase with GDP per capita.[63] But why is the impact of GDP on total public sector employment insignificant in the estimation of Equations (15)? There might be two explanations to the insignificant nature of the coefficient for GDP per capita. First, in the estimation of the System of Equations (14), we use the dataset from the *World Bank Public Sector Employment & Wage Dataset* while we are using the *ILO Public Sector Dataset* to estimate the Equation (15). These two datasets cover different countries and periods and, therefore, we can have different results. Second, the definition of total public sector employment we used in the estimation of Equation (15) consists of seven categories: except for employees at the central and subnational governments, it includes employees in education, health, police, armed forces and public enterprises. It must be that public employees in at least one of these categories decrease with GDP per capita and, therefore, total public sector employment is not increasing with it. However, due to the limitation of our data, we are not able to find out which category of public sector employment that decreases with GDP per capita explicitly.

Among the control variables, we find that the degree of urbanization is positively correlated with the level of total public sector employees as a percentage of population. This result is consistent with Kraay and van Rijckeghem's (1995) finding. These authors

[63] Please refer to Table 7.

argue that urbanization stimulates the demand for certain pubic services, such as infrastructure, social order etc., which drives the public sector to hire more employees.

Regarding the determinants of the level of public sector employees as a percentage of labor force, we find that the estimation results in Table 9 are quite consistent with those in Table 8. All significant coefficients in the estimation of public sector employment as a percentage of population are still significant in the estimation of public sector employment as a percentage of labor force with the same sign. The only difference is that the coefficient for the openness index, measured by the sum of exports and imports of goods and services as a share of GDP, is positively significant at 5% level. This finding is in line with Rodrik's (1996, 1997) argument that relative safe government jobs represent partial insurance against external risk faced by the domestic economy.

The estimation results for the System of Equations (14) explain the structural change of the public sector employment. Fiscal decentralization policy shifts the central government employees to the subnational level, and, therefore, causes the structural change in public sector employment. The estimation result for Equation (15) explains the differences in the levels of total public sector employment as a percentage of population and labor forces across countries and over time. The degree of fiscal decentralization, political constitution, the degree of urbanization and the openness of the country help us to explain this variation. The level of total public sector employees as a percentage of population is higher in a unitary country and increases with extent of fiscal decentralization, as well as the degree of urbanization and the exposure to risk. The estimates for Equation (15) help explain why the level of total public sector employees as a percentage of population increases in some countries but decreases in the others during

the period between 1985 and 2005. They also explain why the level of total public sector employees as a percentage of population in some countries is higher or lower than that in the others at a given point of time.

Figure 2: The Main Components of Public Sector Employment According to World Bank

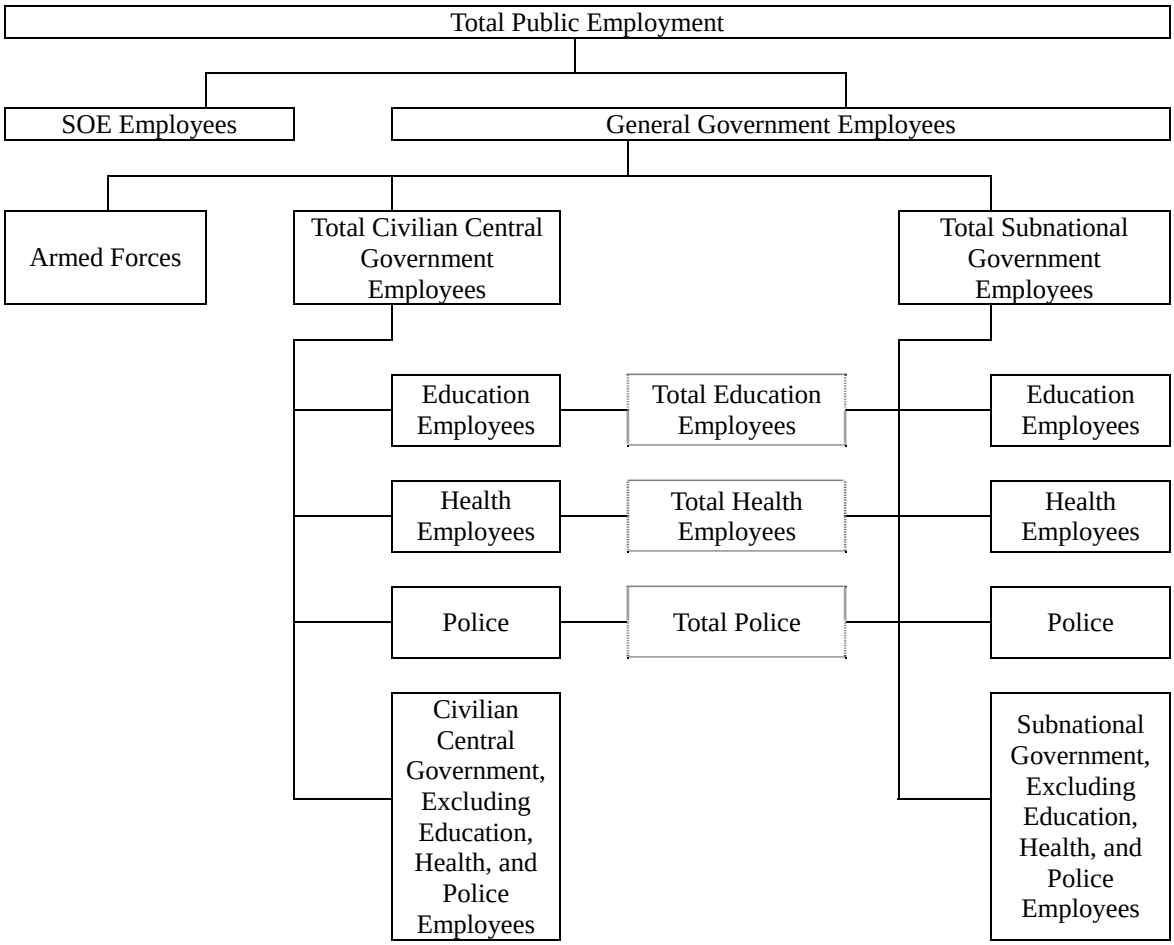

Figure 3: The Unweighted Average Level of Central and Subnational Government Employees for OECD and non-OECD Countries in 1995 and 2000

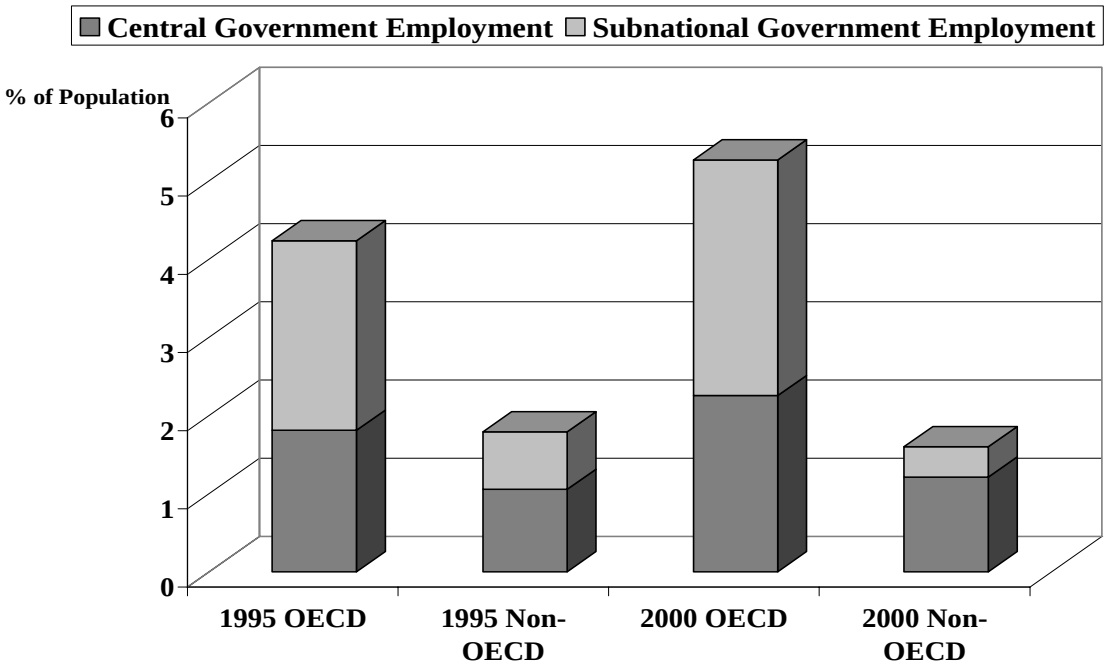

Figure 4: The Main Components of Public Sector Employment According to ILO

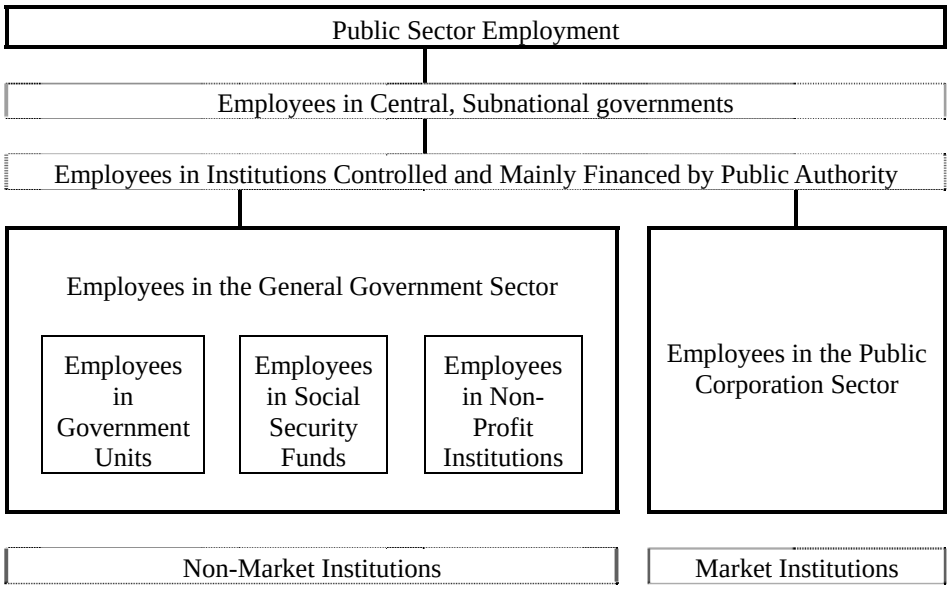

Figure 5: Time Trend of the Unweighted Averages of the Levels of Total Public Sector Employees as a Percentage of Population for OECD and non-OECD Countries

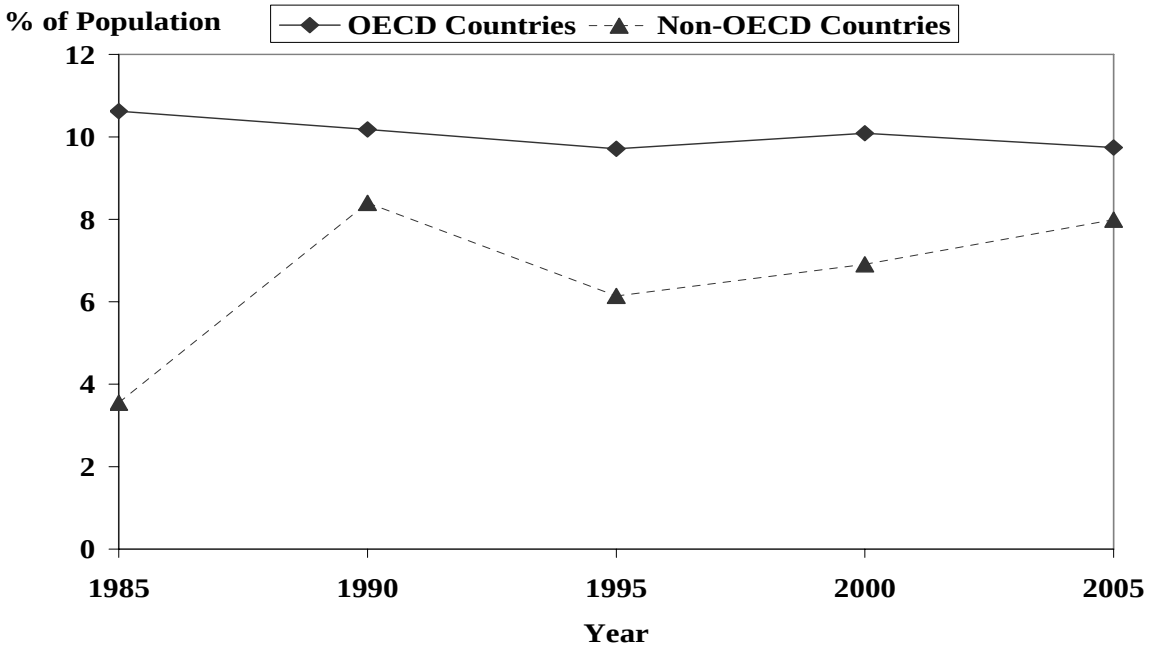

Figure 6: Time Trend of the Unweighted Averages of the Subnational Shares on Public Expenditure for OECD and non-OECD Countries

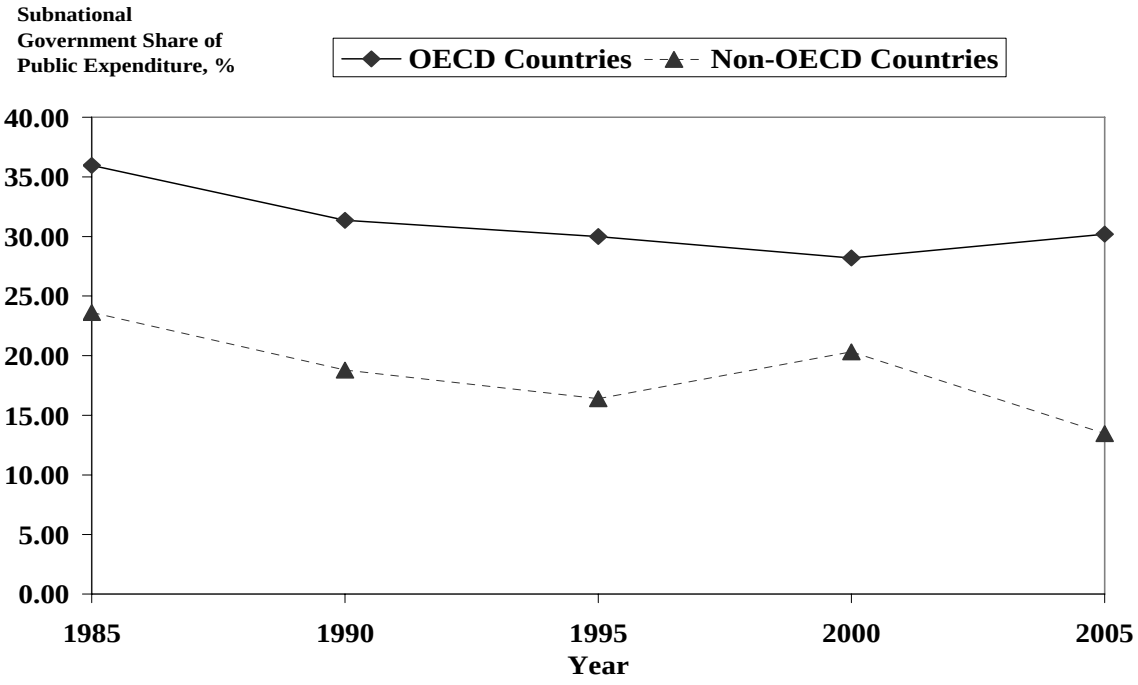

Table 1: The Unweighted Averages of the Levels of Central and Subnational Government Employees as a Percentage of Population for OECD and Non-OECD Countries for 1995 and 2000

	1995		2000	
Country	**Central Government Employees**	**Subnational Government Employees**	**Central Government Employees**	**Subnational Government Employees**
OECD Countries	1.81	2.43	2.25	3.01
	(20)	(20)	(15)	(15)
Non-OECD Countries	1.05	0.74	1.21	0.39
	(13)	(13)	(9)	(9)
All Sample	1.51	1.76	1.86	2.03
	(33)	(33)	(24)	(24)

The quantities in (.) are the number of observations.
Source: *World Bank Public Sector Employment & Wage Dataset* and *Schiavo-Campo et al. (1997b).*

Table 2: The Unweighted Averages of the Levels of Total Public Sector Employment as a Percentage of Population for OECD and Non-OECD Countries

Country	**1985**	**1990**	**1995**	**2000***	**2005***
	10.62	10.18	9.71	10.09	9.74
	(9)	(10)	(17)	(20)	(8)
Non-OECD Countries	3.55	8.40	6.14	6.91	7.99
	(4)	(7)	(11)	(15)	(7)
All Sample	8.44	9.45	8.31	8.73	8.93
	(13)	(17)	(28)	(35)	(15)

The quantities in (.) are the number of observations.
* The observation of the year 2000 is obtained as the follows: calculate the 5-year average from 1996 to 2000 for each country, and then calculate the unweighted average of all countries in the group. The observation of the year 2005 is obtained by the same way as the year 2000, except for using the data from 2001 to 2004.
Source: *International Labor Organization Public Sector Dataset.*

Table 3: The Unweighted Averages of the Subnational Government Shares on Public Expenditure for OECD and Non-OECD Countries

Country	1985*	1990*	1995*	2000*	2005*
OECD Countries	35.96	31.36	29.99	28.20	30.19
	(9)	(10)	(17)	(20)	(8)
Non-OECD Countries	23.63	18.79	16.39	20.33	13.46
	(4)	(7)	(11)	(15)	(7)
All Sample	32.17	26.18	24.64	24.83	22.38
	(13)	(17)	(28)	(35)	(15)

The quantities in (.) are the number of observations.
* These observations are obtained as the follows: calculate the 5-year average of the previous five years for each country, and then calculate the unweighted average of all countries in the group.
Source: *The Government Finance Statistics* of the IMF.

Table 4: Description of Variables

Variable	*Label*	Definition	Units	Source
Central Government Employees	*CGE*	Central Government Employees as % of Population	%	*World Bank Public Sector Employment & Wage Dataset* Website*, and Schiavo-Campo *et al.* (1997b)
Subnational Government Employees	*SGE*	Subnational Government Employees as % of Population	%	*World Bank Public Sector Employment & Wage Dataset* Website*, and Schiavo-Campo *et al.* (1997b)
Public Sector Employees	*PSE*	Total Public Sector Employees as % of Population	%	*International Labor Organization Public Sector Dataset* Website**
Fiscal Decentralization	*DEC*	Share of Subnational Government Expenditure on Public Expenditure	%	The *Government Finance Statistics* of the IMF
Unitary Country	*UNI*	1 for Unitary Countries	0/1	Internet***
Local Election	*ELE*	0 if neither local governor nor local legislature are locally elected, 1 if the local governor is appointed but the legislature is elected and 2 if both are locally elected.	0/1/2	The *Database of Political Institutions* of the World Bank****
OECD Country	*OECD*	1 for OECD Countries	0/1	OECD Website*****
GDP per capita	*GDPPC*	Constant 2000 US$	1,000	World Development Indicators (2005)
Openness	*TRADE*	Sum of Exports and Imports of Goods and Services Measured as a Share of GDP	%	World Development Indicators****** (2005)
Urbanization Ratio	*URB*	Share of Urban Population on Population	%	World Development Indicators****** (2005)

* http://sima-ext.worldbank.org/publicsector/, accessed June 11, 2007
** http://laborsta.ilo.org/, accessed June 11, 2007
*** http://en.wikipedia.org/wiki/Unitary_state, accessed June 11, 2007
****http://econ.worldbank.org/WBSITE/EXTERNAL/EXTDEC/EXTRESEARCH/0,,contentMDK:20649465~pagePK:64214825~piPK:64214943~theSitePK:469382,00.html, accessed June 11, 2007
***** http://www.oecd.org/document/58/0,2340,en_2649_201185_1889402_1_1_1_1,00.html, accessed June 11, 2007
****** Variables which resource is the World Development Indicators have the definition provided by the World Bank.

Table 5: Descriptive Statistics for the Estimation of the System of Equations (14)

Variable	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Central Government Employees (% of Population)	57	1.66	1.27	0.05	5.27
Subnational Government Employees (% of Population)	57	1.87	2.09	0.20	10.14
Fiscal Decentralization	57	24.81	13.47	5.43	57.43
GDP per capita	57	14.76	9.16	1.82	32.52
Openness	57	66.98	34.12	16.51	167.98
Degree of Urbanization	57	65.92	17.48	26.17	96.62

Table 6: Descriptive Statistics for the Estimation Equation (15)

Variable	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Public Sector Employees (% of Population)	108	8.73	5.29	0.90	34.31
Public Sector Employees (% of Labor Force)	108	18.55	10.33	2.04	72.72
Fiscal Decentralization	108	25.54	14.76	2.41	59.02
GDP per capita	108	14.72	9.32	0.67	34.84
Openness	108	71.65	40.49	14.04	204.67
Degree of Urbanization	108	64.84	18.98	15.53	96.98

Table 7: Estimated Coefficients on Central and Subnational Government Employment

	SUR Approach		OLS Approach	
	Central Government Employees (as % of Population)	Subnational Government Employees (as % of Population)	Central Government Employees (as % of Population)	Subnational Government Employees (as % of Population)
Expenditure Decentralization	-	0.054	-	0.055
	-	(2.82)**	-	(2.16)*
Unitary Country	0.860	-	0.916	-
	(2.81)**	-	(3.16)**	-
Local Election	-	-0.901	-	-0.902
	-	(3.00)**	-	(2.18)*
OECD Country	-0.274	-0.156	-0.279	-0.154
	(0.61)	(0.24)	(0.55)	(0.32)
GDP per capita	0.080	0.125	0.080	0.124
	(3.04)**	(3.06)**	(2.72)**	(3.45)**
Openness	0.008	-0.001	0.008	-0.001
	(2.02)*	(0.11)	(1.55)	(0.11)
Degree of Urbanization	0.001	0.019	0.001	0.019
	(0.05)	(1.24)	(0.07)	(1.48)
Constant	-0.605	-1.407	-0.652	-1.427
	(0.91)	(1.37)	(1.14)	(1.37)
Observations	57	57	57	57
R-squared			0.39	0.54

Absolute value of z statistics is given in parentheses; for OLS estimators, robust z-statistics is given.
In each regression model we include a time dummy, but we do not report the coefficients on that dummy.
* and ** denote significance at 5% and 1% level respectively.
The correlation of residuals from SUR model is 0.12.

Table 8: Estimated Coefficients on Total Public Sector Employment

	Dependent Variable: Total Public Sector Employees as % of Population		
	Fixed Effects Model	Random Effects Model	GMM Approach
Expenditure Decentralization	0.015	0.015	0.141
	(0.18)	(0.18)	(2.22)*
Unitary Country	-	5.115	4.453
	-	(3.48)**	(3.17)**
Local Election	2.468	1.619	-0.430
	(3.91)**	(1.22)	(0.30)
OECD Country	-	-1.685	1.198
	-	(0.50)	(0.53)
GDP per capita	0.543	0.276	-0.001
	(1.29)	(1.34)	(0.01)
Openness	0.011	0.019	0.030
	(0.41)	(1.27)	(1.83)
Degree of Urbanization	0.267	0.007	0.088
	(1.30)	(0.16)	(2.24)*
Constant	-16.878	0.146	-5.780
	(1.10)	(0.04)	(1.86)
Observations	108	108	108
Number of countries	41	41	
R-squared	0.38		

Absolute value of robust t-statistics is given in parentheses.
In each regression model we include a set of time dummies, but we do not report the coefficients on those dummies.
* and ** denote significance at 5% and 1% level respectively.
The estimated serial correlation coefficient for Fixed Effects and Random Effects models is 0.275.
The instrumental variables used in the GMM are ethnic, language and religion fractionalization indices.

Table 9: Estimated Coefficients on Total Public Sector Employment

	Dependent Variable: Total Public Sector Employees as % of Labor Force		
	Fixed Effects Model	Random Effects Model	GMM Approach
Expenditure Decentralization	-0.057	-0.037	0.236
	(0.36)	(0.22)	(1.97)*
Unitary Country	0.000	9.413	8.397
	(.)	(3.34)**	(2.80)**
Local Election	4.586	3.570	-0.749
	(3.76)**	(1.34)	(0.27)
OECD Country	0.000	-2.094	4.425
	(.)	(0.31)	(1.00)
GDP per capita	0.983	0.441	-0.180
	(1.05)	(1.07)	(0.77)
Openness	0.018	0.038	0.068
	(0.34)	(1.20)	(2.18)*
Degree of Urbanization	0.287	0.013	0.205
	(0.75)	(0.14)	(2.80)**
Constant	-12.712	4.465	-9.704
	(0.43)	(0.55)	(1.60)
Observations	108	108	108
Number of Countries	41	41	
R-squared	0.38		

Absolute value of robust t-statistics is given in parentheses.
In each regression model we include a set of time dummies, but we do not report the coefficients on those dummies.
* and ** denote significance at 5% and 1% level respectively.
The estimated serial correlation coefficient for Fixed Effects and Random Effects models is 0.212.
The instrumental variables used in the GMM are ethnic, language and religion fractionalization indices.

CHAPTER FIVE: CONCLUSIONS

This dissertation seeks to investigate the relationship between public sector employment and fiscal decentralization. We develop a theoretical model that helps us understand the interaction of the central executive's and subnational governor's decisions on the level of public employees at the central and subnational levels. Our empirical work shows that fiscal decentralization policy shifts central government employees to the subnational government level and that the increase in public employees at the subnational government level overwhelms the decrease in public employees at the central level. As a result, the level of total public sector employees increases with the degree of fiscal decentralization of a country. We also find that the levels of total public sector employees as a percentage of population are higher in unitary country systems than those in federal countries. The level of public employment also increases with the degree of urbanization and with the exposure to risk of a country.

In Chapter Two, we review the literature on this topic. First, we present three hypotheses that explain the variation of public sector employment across countries and over time. We also examine studies that relate to the determinants of public sector employment. However, we argue that most previous studies have ignored the structural change in public sector employment that may be generated by fiscal decentralization. Then, we review two different view points on the relationship between decentralization and public sector size, as measured by the ratio of public expenditure or revenue over GDP. From our literature review we find that despite the growing literature on fiscal decentralization issues, there has been so far little theoretical or empirical work done on

the impact of fiscal decentralization on public sector employment. In addition, we also review two prior studies indicating the existence of spatial effects in the determination of fiscal policies on the expenditure of the budget.

In Chapter Three, we develop a two-player-two-period model that allows us to investigate the interaction between the central executive's and the subnational governor's decisions on the amount of public employees at both government levels. The theoretical model yields four hypotheses: first, higher degrees of fiscal decentralization are associated with higher levels of subnational government employment; second, total public sector employment is a function of the degree of fiscal decentralization but the direction is ambiguous, depending on two opposing effects; third, higher levels of GDP per capita are associated with higher levels of subnational government employment; finally, the level of subnational government employees is positively correlated with the ability of the subnational governors to shift the political cost caused from negative subnational budget gaps to the central executive. An important contribution of this dissertation is that we incorporate the production function of public goods into both the central executive's and subnational governor's utility function. Within this framework, we are able to investigate the interaction of decisions on the level of public employees at both the central and subnational governments. The level of total public sector employees can be further expressed as a function of the degree of fiscal decentralization, which our empirical study is based on.

In Chapter Four, we conduct an empirical analysis to test the hypotheses drawn from our theoretical model. We use the SUR methodology and the *World Bank Public Sector Employment & Wage Dataset* for 38 OECD and non-OECD countries in either

1995 or 2000 or both periods to examine the determinant of central and subnational government employment and to investigate the change in subnational government employment relative to the change in central government employment. As a second stage of our empirical estimation, we use the fixed effects and random effects approaches and the *International Labor Organization Public Sector Dataset* for 41 OECD and non-OECD countries over the period from 1985 to 2005 to examine the determinants of the levels of total public sector employees as a percentage of population and labor force. While testing our hypotheses, we find evidence of heteroskedasticity on the residuals. Therefore, in our result tables, we report the robust standard error, which is valid under the condition of heteroskedasticity in an unknown form. We further employ the GMM method with three additional moment conditions in an attempt to improve the estimating efficiency. Our GMM estimators are also valid in the presence of any heteroskedasticity or serial correlation.

With fiscal decentralization policy, the central government transfers some expenditure responsibilities to the subnational governments, which drives the level of subnational government employees up. Our SUR estimation results confirm this hypothesis. We also find that the level of central government employees is higher in a unitary country than in a country with federalism constitution. This may be because in a unitary country the central government has direct authority over the subnational governments and control over most resource of the country, which allows the central executive to hire more public employees. Our empirical results also indicate that the level of subnational government employees is lower in a country whose subnational governor and legislature are elected locally than that in a country whose subnational governor and

legislature are appointed by the central government. This would be because locally elected governors take more direct responsibility for the negative subnational budget gap than governors appointed by the central government.

In terms of the level of total public sector employment, the empirical results of GMM approach show that it increases with the degree of fiscal decentralization. This is somewhat a surprising result. Typically, more public employment is associated with an excessive number of public sector employees, and, therefore, with unproductive spending. On the other hand, fiscal decentralization policy has been generally thought to result in an increase in allocative efficiency, since a decision on public expenditures made by a level of government that is closer and more responsive to a local constituency is more likely to reflect the demand for local services than a decision made by a remote central government. In addition, decentralization has been thought as having the potential of improving competition among governments and of facilitating technical innovations. Therefore, one might expect that fiscal decentralization should help to retrench the public sector employment. However, from our empirical result, we find that subnational governors without taking full responsibility for subnational public finance tends to bloat the levels of subnational government employees and ask the central government to pay the bill. As a result, the level of total public sector employees increases with fiscal decentralization policy. These findings are much in line with Oates' (1972, 1985) and Wallis'[64] anticipated results, but they are based on different explanations.

Among the control variables, we find that the levels of total public sector employees as a percentage of population are higher in unitary countries than those in federal countries. Also, consistent with Kraay and van Rijckeghem's (1995) study, we

[64] Wallis' argument has been cited in Oates (1985).

find that the level of public sector employees increases with the degree of urbanization.

To capture the demographic character of our variable of interest, public employment, we also estimate the determinants of the level of public sector employees as a percentage of labor force. The results from this estimation are quite consistent with those found with the level of public sector employees as a percentage of population as the dependent variable. The only difference is that in this estimation the coefficient of the openness index is significantly positive at 5% level. This finding supports Rodrik's (1997) argument that government jobs represent a partial insurance against external risks faced by the country.

Employing the two most commonly used spatial dependency tests, Moran's *I* and Getis and Ord's *G* statistics, we also find evidence of spatial dependency in terms of the level of public sector employees as a percentage of population among the countries in our dataset. Even though from the spatial dependency test, we are not able to see how the spatial effects affect the decision makers in making their policies. However, this finding suggests that while using country's own domestic variables to explain the level of public sector employment, we should not ignore that the neighboring countries' policies also play an important role in determining it.

APPENDIX A: TOTAL PUBLIC SECTOR EMPLOYEES

Total Public Sector Employees (as % of Population)						
Year	**Group**	**1985**	**1990**	**1995**	**2000**	**2005**
Albania	ECA			8.58	6.96	
Argentina	LAC				3.55	
Australia	OECD	10.8	10.54	8.74	8.05	7.42
Belgium	OECD	9.13	9.62	10.08	10.23	
Bolivia	LAC			2.81	2.63	
Brazil	LAC		5.22	5.01	4.65	
Bulgaria	ECA				15.24	9.66
Canada	OECD	11	11.23	10.27	9.24	9.14
Chile	LAC				3.33	
Colombia	LAC				1.07	
Costa Rica	LAC					5.3
Croatia	ECA				15.77	12.51
Czech Republic	ECA				10.82	
Denmark	OECD				17.71	
Dominican Republic	LAC			3.76	4.29	
Ethiopia	AF					0.9
Finland	OECD	13.87	14.34	10.84	11.03	
France	OECD				8.25	
Germany	OECD			8.79		
Hungary	ECA			7.92	9.26	8.5
India	AS	2.35	2.3	2.19	1.98	
Ireland	OECD		7.73	7.88	7.6	
Italy	OECD			6.44	6.18	
Lithuania	ECA				14.76	12.68
Malaysia	AS	4.76	4.12	3.47	3.26	
Mexico	LAC		5.85	5.22	4.95	
Netherlands	OECD			9.63	9.81	
New Zealand	OECD					5.97
Norway	OECD			18.52	19.02	18.87
Panama	LAC		5.93	5.77		
Poland	ECA			14.45	11.94	9.35
Romania	ECA		34.31	24.54	17.78	10.52
Slovak Republic	ECA				13.39	10.72
South Africa	AF			4.42	4.13	
Spain	OECD	4.71	5.44	5.68	5.91	
Sweden	OECD	19.55	19.55	14.48	13.96	
Switzerland	OECD	8.41		9.36	8.38	7.97
Thailand	AS	3.28	3.49	4.26	4.28	4.37
United Kingdom	OECD	11.06	10.05	9.25	8.88	
United States	OECD	7.01	7.48	7.48	7.27	
Zimbabwe	AF	3.8	3.43	2.76		

Source: International Labor Organization Public Sector Dataset Website, http://laborsta.ilo.org/, accessed June 11, 2007.

APPENDIX B: CENTRAL AND SUBNATIONAL GOVERNMENT EMPLOYEES

Central and Subnational Government Employees (as % of Population)				
	1995		2000	
Country	Central Government Employees	Subnational Government Employees	Central Government Employees	Subnational Government Employees
Albania	1.9	0.2	0.05	0.2
Argentina	0.9	2.8		
Australia	1.3	2.3	0.8	2.08
Belgium	1.7	2.3		
Bolivia	1.2	0.2		
Brazil	0.31	1.26		
Bulgaria	0.9	0.3	0.38	0.38
Canada	1	1.8	1.09	2.06
Chile	0.3	0.2	0.82	0.2
Colombia			4.99	0.49
Croatia	1.6	0.6	1.88	0.43
Czech Republic			4.76	2.32
Denmark	2.8	5.2	3.12	10.14
Finland	2.2	7.7	2.4	8.07
France	2.7	2.2	3.59	2.37
Germany	0.4	2.6		
Hungary	1.4	1.3	1.46	1.56
India	0.4	0.4	0.28	0.56
Indonesia	0.7	0.3	0.74	0.23
Ireland	1.2	0.8	5.27	0.71
Italy	1.3	1.3	3.43	2.49
Lithuania			1.26	0.49
Malaysia	2.3	1.1		
Mexico	1.7	1.72	0.68	0.72
Netherlands	3.9	1.3		
Norway	2.6	1.6		
Poland	0.2	0.4	0.42	0.29
Portugal	1.8	0.8		
Romania			0.51	0.51
Slovak Republic			0.46	0.33
South Africa	1.4	1.1		
Spain	1.3	2	2.3	2.81
Sweden	4.1	5.3		
Switzerland	2.1	2.5		
Thailand	1.2	0.9		
United Kingdom	1.3	2.2	3.06	3.37
United States	1.2	3.2	0.97	5.9
Zimbabwe	0.6	0.2		

Source: Schiavo-Campo, Salvatore, Giulio de Tommaso and Amitabha Mukherjee, "An International Statistical Survey of Government Employment and Pay," World Bank Working Paper: 1771, and World Bank Public Sector Employment & Wage Dataset Website, http://sima-ext.worldbank.org/publicsector/, accessed June 11, 2007.

APPENDIX C: THE SEEMINGLY UNRELATED REGRESSION MODEL

In this appendix, we cover the Seemingly Unrelated Regression (SUR) model as we have applied in the estimation of the System of Equations (14). [65] The SUR model can be viewed as a special case of the generalized regression model, and can be showed as:

$$y_{i,j} = X'_{i,j} \cdot \beta_j + \varepsilon_{i,j}, \qquad i = 1,...,N \qquad j = 1, 2$$

or, with the usual stacking of observation over i,

$$y_j = X_j \cdot \beta_j + \varepsilon_j, \quad j = 1, 2.$$

$$y_j = \begin{pmatrix} y_1 \\ y_2 \end{pmatrix}, \quad X_j = \begin{bmatrix} X_1 & 0 \\ 0 & X_2 \end{bmatrix}, \quad \beta_j = \begin{pmatrix} \beta_1 \\ \beta_2 \end{pmatrix}, \quad \varepsilon_j = \begin{pmatrix} \varepsilon_1 \\ \varepsilon_2 \end{pmatrix}$$

$$E[\varepsilon_j] = 0, \quad E[\varepsilon_j \varepsilon_j'] = V, \qquad V = \sum \otimes I, \qquad \sum = \begin{bmatrix} \sigma_{11} & \sigma_{12} \\ \sigma_{21} & \sigma_{22} \end{bmatrix},$$

where $\otimes$ is the Kronecker production notation.

The SUR model permits nonzero covariance between the error terms ε_{ij} and ε_{ik} for a given individual i across equations j and k, i.e., $Cov(\varepsilon_{i,j}, \varepsilon_{i,k}) = \sigma_{ij}$, while assuming $Cov(\varepsilon_{i,j}, \varepsilon_{i',k}) = 0$, where i' represents any individual other than individual i. It is the potential nonzero covariance across equations j and k that allows for an improvement in efficiency of the generalized least squares (GLS) relative the ordinary least squares (OLS) estimator of each β_j.

Denoting the element in the i^{th} row and j^{th} column of $\sum^{-1}$ by σ^{ij}, i.e., $\sum^{-1} \equiv [\sigma^{ij}]$. Assuming $\sum$ is known, the GLS estimator of the vector β is

[65] For more detail discussion on this, please refer to Section 15.4 of Greene (2000).

$$\hat{\beta}_{GLS} = [X'V^{-1}X]^{-1}X'V^{-1}y$$
$$= [X'(\Sigma^{-1} \otimes I)X]^{-1}X'(\Sigma^{-1} \otimes I)y$$
$$= \begin{bmatrix} \sigma^{11}X'_1X_1 & \sigma^{12}X'_1X_2 \\ \sigma^{21}X'_2X_1 & \sigma^{22}X'_2X_2 \end{bmatrix}^{-1} \begin{bmatrix} \sum_{j=1}^{2} \sigma^{1j}X'_1y_j \\ \sum_{j=1}^{2} \sigma^{2j}X'_2y_j \end{bmatrix}.$$

The asymptotic covariance matrix for the GLS estimator is the inverse matrix in the above equation.

Zellner (1962) and Dwivedi and Srivastava (1978) have analyzed some special cases of this model. First, if the equations are actually unrelated, that is, $\sigma_{ij} = 0$ for $i \neq j$, then the GLS estimator is the OLS estimator. Second, if the regressors of these equations are identical, that is, $X_i = X_j$, then $\hat{\beta}_{OLS} = \hat{\beta}_{GLS}$. However, the greater the correlation of the disturbances, the greater the efficiency gain accruing to GLS.

APPENDIX D: HOMOSKEDASTICITY TESTS

In this appendix, we introduce two popular tests for heteroskedasticity: the White test and the Breusch and Pagan test. The homoskedasticity assumption, $Var(u_i \mid X) = \sigma^2$, can be replaced with the weaker assumption that the squared error, u_i^2, is uncorrelated with all the independent variables, the squares of the independent variables, and all the cross products. This observation motivated White (1980) to propose a test for heteroskedasticity. The White test is carried out by obtaining $n \cdot R^2$ in the regression of $\hat{u}_i^2$ on a constant and all the independent variables, the squares of the independent variables, and all the cross products. The statistics asymptotically form a chi-squared distribution with $k-1$ degrees of freedom, where k is the number of regressors in this regression, including the constant.

Breusch and Pagan (1979) have devised a Lagrange multiplier test of the hypothesis that $u_i^2 = \sigma^2 \cdot f(\alpha_0 + \alpha' \cdot z_i)$, where z_i is a vector of independent variables. The model is homoskedastic if $\alpha = 0$. The Breusch-Pagan Lagrange multiplier statistic is given by:

$$LM = \frac{1}{2}[(\frac{\hat{u}_i^2}{\hat{u}'\hat{u}/n})'Z(Z'Z)^{-1}Z'(\frac{\hat{u}_i^2}{\hat{u}'\hat{u}/n})].$$

Under the null hypothesis of homoskedasticity, LM is asymptotically distributed as χ^2 with degrees of freedom equal to the number of variables in z_i.

APPENDIX E: FIXED EFFECTS AND RANDOM EFFECTS MODELS

In this appendix, we introduce two common approaches that we employ in the estimation of Equation (15) to control the individual effect, a_i, in the data.[66] The first approach is the fixed effects model. By fixed effects transforming the Equation (15), we obtain Equation (17):

$$\ddot{y}_{i,t} = \ddot{X}_{i,t} \cdot \beta + \ddot{\varepsilon}_{i,t} \tag{17}$$

where $\ddot{y}_{i,t} \equiv y_{i,t} - \bar{y}_i$, $\ddot{X}_{i,t} \equiv X_{i,t} - \bar{X}_i$, $\ddot{\varepsilon}_{i,t} \equiv \varepsilon_{i,t} - \bar{\varepsilon}_i$, $\bar{y}_i = T^{-1}\sum_{t=1}^{T_i} y_{i,t}$, $\bar{X}_i = T^{-1}\sum_{t=1}^{T_i} X_{i,t}$, and $\bar{\varepsilon}_i = T^{-1}\sum_{t=1}^{T_i} \varepsilon_{i,t}$. The time demeaning of the Equation (17) has removed the individual effect, a_i. In absence of a_i in our Equation (17), we can estimate this equation by pooled OLS. Our fixed effects (FE) estimator, $\hat{\beta}_{FE}$, is the pooled OLS estimator from the regression $\ddot{y}_{i,t}$ on $\ddot{X}_{i,t}$, which can be expressed as

$$\hat{\beta}_{FE} = \left(\sum_{i=1}^{N} \sum_{t=1}^{T_i} \ddot{X}_{i,t}' \ddot{X}_{i,t} \right)^{-1} \left(\sum_{i=1}^{N} \sum_{t=1}^{T_i} \ddot{X}_{i,t}' \ddot{y}_{i,t} \right).$$

The robust variance matrix estimator of $\hat{\beta}_{FE}$ is

$$\hat{A}\text{var}\left(\hat{\beta}_{FE}\right) = \left(\ddot{X}'\ddot{X}\right)^{-1} \left(\sum_{i=1}^{N} \ddot{X}_i' \hat{u}_i \hat{u}_i' \ddot{X}_i \right) \left(\ddot{X}'\ddot{X}\right)^{-1}$$

where $\hat{u}_i \equiv \ddot{y}_i - \ddot{X}_i \hat{\beta}_{FE}$ denotes the fixed effects residuals. This robust variance matrix is suggested by Arellano (1987) and the robust standard errors are obtained as the square roots of the diagonal elements of this matrix, which are valid in the presence of any

[66] For a thorough discussion of this topic please refer to Greene (2000), Wooldridge (2000, 2002).

heteroskedasticity or serial correlation.

The second approach to estimate Equation (16) is to apply the random effects model. A random effects analysis puts the individual effect, a_i, into the error term. The random effects model assumes that the individual effect is uncorrelated with each independent variable. Since a_i is in the composite error in each time period, the $u_{i,t}$ are serial correlated across time. Let $\sigma_\varepsilon^2 = \text{Var}(\varepsilon_{i,t})$, $\sigma_a^2 = \text{Var}(a_i)$. Under the random effect assumption, the serial correlation can be expressed as

$$\text{Corr}(u_{i,t}, u_{i,s}) = \sigma_a^2 / (\sigma_a^2 + \sigma_\varepsilon^2), \ \forall\ t \neq s .$$

Wooldridge (2002) derives the GLS transformation that eliminates serial correlation in the errors. The random effects transformation of Equation (15) can be showed as

$$\tilde{y}_{i,t} = \tilde{X}_{i,t} \cdot \beta + \tilde{\varepsilon}_{i,t} \tag{18}$$

where $\tilde{y}_{i,t} \equiv y_{i,t} - \lambda \bar{y}_i$, $\tilde{X}_{i,t} \equiv X_{i,t} - \lambda \bar{X}_i$, $\tilde{\varepsilon}_{i,t} \equiv \varepsilon_{i,t} - \lambda \bar{\varepsilon}_i$, and $\lambda = 1 - [\sigma_\varepsilon^2 / (\sigma_\varepsilon^2 + \sigma_a^2)]^{1/2}$. The tilde again denotes the time averages. The random effects estimator, $\hat{\beta}_{RE}$, is the pooled OLS estimator from the regression $\tilde{y}_{i,t}$ on $\tilde{X}_{i,t}$, and can be expressed as

$$\hat{\beta}_{RE} = \left(\sum_{i=1}^{N} \sum_{t=1}^{T_i} X_{i,t}' \hat{\Omega}^{-1} X_{i,t} \right)^{-1} \left(\sum_{i=1}^{N} \sum_{t=1}^{T_i} X_{i,t}' \hat{\Omega}^{-1} y_{i,t} \right)$$

where $\hat{\Omega}$ takes the form

$$\hat{\Omega} = \begin{pmatrix} \hat{\sigma}_a^2 + \hat{\sigma}_\varepsilon^2 & \hat{\sigma}_a^2 & \cdots & \hat{\sigma}_a^2 \\ \hat{\sigma}_a^2 & \hat{\sigma}_a^2 + \hat{\sigma}_\varepsilon^2 & \cdots & \vdots \\ \vdots & \vdots & \ddots & \hat{\sigma}_a^2 \\ \hat{\sigma}_a^2 & \cdots & \hat{\sigma}_a^2 & \hat{\sigma}_a^2 + \hat{\sigma}_\varepsilon^2 \end{pmatrix}.$$

$\hat{\sigma}_{\varepsilon}^2$ and $\hat{\sigma}_a^2$, are consistent estimators of σ_{ε}^2 and σ_a^2, which are based on the pooled OLS or fixed effects residuals. The robust variance matrix estimator of $\hat{\beta}_{RE}$ is given as

$$\hat{A}\text{var}\left(\hat{\beta}_{RE}\right)=\left(\sum_{i=1}^{N} X_i'\hat{\Omega}^{-1}X_i\right)^{-1}\left(\sum_{i=1}^{N} X_i'\hat{\Omega}^{-1}\hat{v}_i\hat{v}_i'\hat{\Omega}^{-1}X_i\right)\left(\sum_{i=1}^{N} X_i'\hat{\Omega}^{-1}X_i\right)^{-1}$$

where $\hat{v}_i \equiv y_i - X_i\hat{\beta}_{FE}$ is the random effects residuals. The robust standard errors are obtained in the same way from the robust variance matrix estimator as we have discussed in the case of the fixed effect approach.

APPENDIX F: THE TEST FOR INDIVIDUAL EFFECTS VERSUS POOLED OLS

Recall our estimation of Equation (15):

$$PSE_{i,t} = \beta_0 + \beta_1 \cdot DEC_{i,t} + \beta_2 \cdot UNI_{i,t} + \beta_3 \cdot ELE_{i,t} + \beta_4 \cdot W_{i,t} + a_i + \varepsilon_{i,t} \quad (15)$$

where a_i are called an individual effect or individual heterogeneity. We rewrite Equation (15) as:

$$y_{i,t} = X_{i,t} \cdot \beta + u_{i,t} \quad (16)$$

where $y_{i,t}$ is our dependent variable, public sector employees as a percentage of population of country i at time t and $X_{i,t}$ includes a constant term and all our dependent variables of country i at time t. $u_{i,t} \equiv a_i + \varepsilon_{i,t}$ are the composite errors. Under the assumption that there is no correlation between $X_{i,t}$ and $u_{i,t}$, the pooled OLS estimator can be used to obtain a consistent estimator of β in estimation of Equation (16). Ignoring the individual effects, the pooled OLS estimator is biased and inconsistent if the individual effects are correlated with the dependent variables.

Under the assumption of the individual effects being jointly equal to zero, the pooled OLS estimator is the best linear unbiased estimator. Breusch and Pagan (1979) have derived a statistic using the Lagrange multiplier in a likelihood setting to test the presence of individual effects. The null hypothesis of the absence of individual effects, statistically equivalent to $H_0 : \sigma_a^2 = 0$, is against the alternative hypothesis of the presence of individual effects, or $H_1 : \sigma_a^2 \neq 0$. The test statistic is given by

$$LM = \frac{nT}{2(T-1)}\left[\frac{\sum_{i=1}^{N}\left[\sum_{t=1}^{T} e_{i,t}\right]^2}{\sum_{i=1}^{N}\sum_{t=1}^{T} e_{i,t}^2} - 1\right]^2$$

where $e_{i,t}$ is the OLS residuals. Under the null hypothesis, the *LM* statistic forms a chi-squared distribution with one degree of freedom.[67]

[67] For detailed discussion of this section please refer to Greene (2000), Chapter 14.

APPENDIX G: THE HAUSMAN TEST

The distinction between fixed and random effects models is the assumption whether or not the individual effects are correlated with the independent variables. Hausman (1978) test, based on the difference between the random effects and fixed effects estimates, can be used to test the correlation between the individual effects and the independent variables. Under the null hypothesis of no correlation, both fixed effects and random effects estimates are consistent, but fixed effects estimate is inefficient, whereas under the alternative hypothesis, the fixed effects estimate is consistent, but the random effects estimate is not. Under the null hypothesis, these two estimates should not differ systematically. The Hausman statistic can be computed as follows:

$$H = (\hat{\beta}_{FE} - \hat{\beta}_{RE})'[\hat{\mathrm{A}}\,\mathrm{var}(\hat{\beta}_{FE}) - \hat{\mathrm{A}}\,\mathrm{var}(\hat{\beta}_{RE})]^{-1}(\hat{\beta}_{FE} - \hat{\beta}_{RE}) .$$

Under the null hypothesis, the Hausman statistic is asymptotically distributed as chi-squared with $k-1$ degrees of freedom, where k is the number of regressors in this regression, including the constant.

APPENDIX H: THE GENERALIZED METHOD OF MOMENTS ESTIMATION

In this appendix, we introduce the third approach, the Generalized Method of Moments (GMM) estimation, which we employed to estimate Equation (15). We have rewritten the Equation (15) as:

$$y_{i,t} = X_{i,t} \cdot \beta + u_{i,t} \tag{16}$$

The intuition of GMM is to use the moment conditions that are assumed to be satisfied to minimize the GMM objective function. Thus, we need the moment condition $E(X'u) = 0$ in Equation (16) to be satisfied. In testing for the endogeneity of variable the degree of fiscal decentralization, we have a set of three additional exogenous variables. Let Z be the set of our exogenous variables, including the independent variables in Equation (16) and three fractionalization index variables. Consequently, our moment condition can be rewritten as $E(Z'u) = 0$. Our GMM method is to choose an estimator to minimize the objective function:

$$J(\beta) = n \cdot \bar{g}(\beta)' W \, \bar{g}(\beta),$$

where $\bar{g}(\beta) = \frac{1}{n} Z'u$, W is an $L \times L$ weighting matrix and L is the number of exogenous variables in Z. There are as many GMM estimators as there are choices of weighting matrix W. The efficient GMM estimator is the GMM estimator with an optimal weighting matrix. Let S be the covariance matrix of the moment conditions, that is, $S = \frac{1}{n} E(Z'uu'Z)$. The efficient GMM estimator, $\hat{\beta}_{EGMM}$, is obtained by choosing

$W = S^{-1}$ and can be expressed as:[68]

$$\hat{\beta}_{EGMM} = (X'ZS^{-1}Z'X)^{-1}X'ZS^{-1}Z'y$$

with asymptotic variance

$$\hat{A}\text{var}(\hat{\beta}_{EGMM}) = (\frac{1}{n}X'ZS^{-1}Z'X)^{-1}.$$

Under the condition that there are no endogenous regressors in our regression model and we have additional moment conditions, our efficient GMM estimator is that of Cragg's heteroskedasticity OLS. This estimator is more efficient than OLS in the presence of heteroskedasticity of unknown form and the efficiency gains drive from the additional moment conditions (Davidson & MacKinnon, 1992)

[68] For more detail discussion on GMM, please refer to Greene (2000), Chapter 11 and Wooldridge (2002), Chapter 14.

APPENDIX I: SPATIAL DEPENDENCY TESTS

Spatial dependence tests measure the extent of spatial autocorrelation among observations in a given geographic space. There are a number of tests that are used for this purpose, among which Moran's *I* and Getis and Ord's *G* statistics are most commonly used. We use these two approaches to test for spatial autocorrelation in this study.[69]

The Moran's I statistic is a weighted correlation coefficient used to detect departures from spatial randomness and is considered to be global in the sense that estimates the overall degree of spatial autocorrelation for our dataset. This statistic is given as:

$$I = \frac{n}{S_0} \cdot \frac{\sum_{i=1}^{n} M \cdot \left(y_i - \bar{y}\right) \cdot \left(y_j - \bar{y}\right)}{\sum_{i=1}^{n} \left(y_i - \bar{y}\right)^2}, \forall j \neq i$$

where *M* is the spatial weight matrix, $\bar{y} = \frac{\sum_{i=1}^{n} y_i}{n}$, *n* is the number of observations, and S_0 is a standardization factor which is equal to all summation of all elements in the weight matrix. The expected value of Moran's *I* is $-\frac{1}{(n-1)}$. The null hypothesis for the Moran's I test is the absence of spatial dependence. The *I* statistic for our data exceeding its expected value indicates that there is positive spatial autocorrelation among the observations of our data.

[69] For more detail about these two spatial dependency tests, please refer to Anselin (1988), Anselin and Florax (1995), and Getis and Ord (1992).

The Getis and Ord's *G* statistic is a multiplicative measure of overall spatial association of values which fall within a given distance of each other. The *G* statistic is given as:

$$G = \frac{\sum_{i=i}^{n}\sum_{j=1}^{n} M \cdot y_i \cdot y_j}{\sum_{i=i}^{n}\sum_{j=1}^{n} y_i \cdot y_j}, \forall j \neq i .$$

The expected value of Getis and Ord's *G* statistic is $\frac{\sum_{i=i}^{n}\sum_{j=1}^{n} M}{n(n-1)}$. The *G* statistic for our data exceeding its expected value indicates a clustering.

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