ABSTRACT

Title of Document: ESSAYS ON GOVERNMENT SPENDING AND SUSTAINABLE GROWTH

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The first chapter examines the effect of the composition of federal and state government spending on SO2 air concentrations in the US. The results indicate that a reallocation of spending from RME to PME at the state and local level reduces sulfur dioxide concentrations while the composition of federal spending has no effect. A 10% percent increase in the share of PME spending reduces sulfur dioxide concentrations by the range of 3 to 5% for state and local spending. This is a significant effect since sulfur dioxide concentrations have been falling at an annual average rate of 5% from 1980 to 2008. The results are robust to various sensitivity checks.

The second chapter documents the creation of a US government spending allocation database that provides new data on a set of disaggregated government spending categories covering all the states in the US for the period 1983-2008. The data allows for the comparison of federal versus state and local government spending

over time on various spending items. This is achieved by categorizing and aggregating expenditures for over 1,500 federal programs and combining data on state and local government spending. The key challenge in separating federal and state and local government spending is the issue of double counting since part of state and local spending is from the federal government. The dataset presented will aid researchers in separately accounting for both state and local, as well as federal spending in future research.

Finally, the third chapter examines fiscal spending and economic growth in the presence of imperfect markets. Political economy factors tend to induce many governments to spend on private goods (RME) to the detriment of spending on social and public goods (PME). This bias in spending patterns is particularly costly for economic growth when capital markets are imperfect. A theoretical model on government spending and growth is developed and linked quite closely to an empirical model. The empirical results fully corroborate the hypothesis that spending biases in favor of non-social subsidies (RME) reduce the rate of economic over the long run. The empirical findings are exceptionally robust.

ESSAYS ON GOVERNMENT SPENDING AND SUSTAINABLE GROWTH

By

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Dissertation submitted to the Faculty of the Graduate School of the
University of Maryland, College Park in fulfillment
of the requirements for the degree of
Doctor of Philosophy,
2012

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Acknowledgements

I would like to thank my advisor, Ramón López, for not only being the most significant mentor for the last seven years, but also being one the most influential people in my life and providing the basis of most of my current world view. I would also like to thank my committee members – Maureen Cropper, Ted McConnell, Charles Towe, and Howard Leathers – for significant comments and valuable critique of my research.

I am grateful to my family – my parents and my two brothers – for being hugely supportive of my academic endeavors and indulging my absences while I completed by thesis. I especially would like to thank my parents for literally sacrificing everything to ensure I had a great education. I'd not be here if it were not for their determination.

One of the best things about graduate school was the important friendships I developed. I'd like to thank Amparo for being a close friend and teaching me patience, Candace for being a huge constant and a great friend over the years, Katya for always being there to help even in the most difficult of times, and the Brock family for being there to cheer me up, lend me an ear whenever I needed it, and indulge my excessive movie watching. I would also like to thank Kohei, Qing, Steve, Abby, Nitish, and Elisabeth for their companionship over the years. I'd also like to thank a few individuals for providing invaluable comments and assistance towards my dissertation: Dana, Ariel, Joe, Kabir, Ziyan, Fanqing. I appreciate all your comments as they proved valuable for the final end product. I am also grateful for two mentors early in graduate school experience – Gregmar Galinato and Sebastian Miller – for teaching me a lot about research.

Last but not least, I'd like to thank three significant friends who have been with me since high school in Kenya: Darshit, Hasnain, and Salman. Fate would have it that due to geographical or occupational reasons you would all be awake at the death of night to cheer me on, especially when I ploughed through seemingly impossible tasks. This dissertation is dedicated to our lifelong friendship.

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Chapter 1: Government Spending and Sulfur Dioxide Air Pollution in the US

Chapter 1: Government Spending and Sulfur Dioxide Air Pollution in the US

By: Asif Islam

1. Introduction

Government spending is economically justified for certain activities where externalities or credit market failures exist. However a significant portion of government spending has little economic justification. This paper explores the environmental implications when a government embarks on broad fiscal policy changes, altering the composition of government expenditures towards correcting market imperfections and increasing the provision of public goods. This paper specifically investigates the impact of US government spending on US sulfur dioxide concentrations for the time period 1985-2008. The effect of government spending is examined at the state and local level, as well as federal expenditures.

Productive and wasteful government spending are distinguished by creating two categories – government spending on market-promoting goods (PME) and spending on market restricting goods (RME). PME spending encompasses pure public goods, which are non-rival and non-excludable, and spending that alleviates market failures. Under this characterization, government expenditures on health, education, affordable housing, social welfare, environment, and research and development are considered PME expenditures. Research and development spending fall under PME spending due to the positive externalities generated by R & D activities and the tendency for the private sector to under-invest in them. RME spending involves subsidies to firms for activities such as product promotion, commodity market subsidies, grants to corporations, bailouts of failed private financial institutions etc. PME expenditures promote activities where government intervention is justified, and thus are considered productive government spending. In contrast, RME spending tends to crowd out private investment and encourage inefficient rent-seeking (hence market-restricting). Thus RME expenditures are deemed as wasteful spending. The classification presented here is not novel and has been presented in the literature (López, Galinato, and Islam 2011; López and Galinato, 2007).

The set of broad fiscal spending categories described above can affect the environment via the following mechanisms. PME expenditures tend to promote human capital intensive activities while RME expenditures tend to promote more physical capital intensive economic activities, thus, a reallocation from RME to PME would improve environmental quality via a composition effect. On the other hand such a reallocation may increase economic activity, effectively increasing pollution via a scale effect. The reallocation from RME to PME may increase incomes resulting in a higher demand for environmental quality, or promote R&D that generates pollution-saving technologies. Such a reallocation of spending may also alter the consumption mix towards less pollution intensive goods making pollution abatement much easier (see Seldon and Song, 1995; Orecchia and Tessitore, 2011). Finally reallocating spending from RME to PME may increase the awareness of pollution and its harmful effects thereby reducing pollution (McConnell, 1997; Ferrer-i-carbonell et al., 2004). Electric utilities account for two thirds of sulfur dioxide emissions in the US. Given the range of output elasticities in the literature for energy and electricity (see Table A17), we expect macro-economic factors to have an impact on SO2 emissions.

An empirical question is whether the effects of a reallocation spending from PME to RME on the environment are stronger at the state and local or federal government. On one hand, proponents of spending at the federal level point out race to the bottom scenarios, inter-state externalities, or claim that state governments do not have the level of expertise to carry out fiscal policy effectively for certain items, and may have soft budgets with the expectation of federal bailouts. On the other hand, States are likely to be more representative of its citizen's preferences, be subject to less red tape, be open to more experimentation with policy and also have a higher degree of accountability (Tanzi, 1995). Because fiscal policy has varying goals, spending compositional changes that achieve environmental improvements is not necessarily indicative of the efficiency of spending as a whole. Differences between federal and state spending reallocation that improves the environment can be interpreted as certain mechanisms linking broad fiscal spending to environment outcomes may be stronger or weaker depending on the level of government. For instance, state governments may be better providers of public goods, and thus a reallocation of RME spending to PME at the state level may result in a greater decline in pollution than a reallocation of fiscal spending at the federal level.

The use of Sulfur dioxide air concentrations in this study is ideal for four reasons: (i) It is a pollutant generated by production activities and thus amenable to the mechanisms linking fiscal policy and environmental outcomes, (ii) Sulfur dioxide regulation by the EPA is tractable, especially via regulation of utilities, (iii) Data for sulfur dioxide concentrations are comprehensive and available for a large period of time over a large number of sites across states, and (iv) Studies have shown that Sulfur Dioxide air pollution is highly correlated with other local pollutants such as Particulate Matter (PM 2.5) and may also be a precursor to global pollutants (Ward, 2009; Kim et al., 2005).

This study adds to a long literature that has examined the determinants of air pollutants in the US. A few studies have examined the impact of the 1990 Clean Air Act Amendments on PM10 concentrations (Aufhammer et al., 2009; Aufhammer et al.,2011), while others have examined the effects of regulation on Ozone (Henderson, 1996), and more recently SO2 concentrations (Carlson et. al, 2000; Greenstone, 2004). In addition to regulation, community characteristics have also been found to be significant determinants of pollutants (Brooks and Sethi, 1997). There are no studies that have specifically examined the effect of the composition of government spending on air pollution in the US, and this study fills that gap in the literature.

This study builds on López, Galinato, and Islam (2011), which explores a similar relationship between government spending composition and pollution across countries. Focusing on the US alone allows for a breakdown of the composition of government spending by the state and federal level. In addition, a more precise categorization of government spending is accomplished using more disaggregated data. As far as I know, this is the first study to examine the composition of spending by different levels of government on air pollution in general. This is possible due to the creation of a new panel dataset of government expenditures spanning all states, covering the time period of 1983 to 2008 (Islam, 2011). One limitation of López, Galinato, and Islam (2011) is that it is difficult to account for regulation in cross-country studies. By restricting the study to the US, this paper is able to account for air pollution regulation policy and also take advantage of the comprehensive data available for US SO2 concentrations in terms of coverage over geographic location and time. Also, a new estimation model is used to capture state specific time varying unobservables using state specific polynomials of a time trend, building on estimations used in literature (Cornwell et al., 1990; Jacobsen et al., 1993; Friedberg, 1998; Wolfers, 2006).

This study provides a timely exploration of an important link between government spending policy and an environmental outcome. The 2008-2009 financial crisis has put US fiscal policy in the forefront of much debate and scrutiny. Thus it is important to understand the consequences on the environment of broad compositional changes in fiscal spending in response to the crisis. This study finds that a reallocation of spending from RME to PME at the state and local level reduces sulfur dioxide concentrations while the composition of federal spending has no effect. A 10% percent increase in the share of PME spending reduces sulfur dioxide concentrations by the range of 3 to 5% for state and local spending. This is a significant effect since sulfur dioxide concentrations have been falling at an annual average rate of 5% from 1980 to 2008. The results are robust to various sensitivity checks[1].

The paper is structured as follows. Section 2 provides a brief review of the empirical environmental literature on the determinants of pollutants. Section 3 provides an overview of trends of sulfur dioxide pollution and regulations implemented in the US. Section 4, 5, 6, 7 and 8 provides the conceptual framework, econometric model, data description, results, and conclusions respectively.

2. Literature Review

The early empirical environment literature on the determinants of pollutants focused on the relationship between income and pollution across countries (Shafik and Bandhopadhyay, 1992; Grossman and Krueger, 1995), with a few studies specific to the US (List and Gallet, 1999; Khanna, 2002). An inverted U relationship between income and pollution was traced across countries, which a few recent studies found to be non-robust (Deacon and Norman, 2007). Empirical studies have examined the relationship between environmental regulation and air pollution in the US (Aufhammer et al., 2009; Aufhammer et al., 2011; Carlson et. al, 2000; Greenstone, 2004; Henderson, 1996) and the link between community characteristics and air pollution (Brooks and Sethi, 1997).

[1] An alternate approach to the current study would be use CGE models as carried out in the literature (Jorgenson and Wilcoxen, 1990). However, CGE models depend upon strong assumptions and lack of data precludes econometric estimation of key supply and demand parameters. Also, CGE models are more effective for global than local pollutants (Bergman, 2005).

A strand of the literature has focused on identifying the channels through which macro-economic factors or policies may affect environmental outcomes. A decomposition of the various proximate determinants of pollution by which trade impacts environmental outcomes is conducted by Antweiler, Copeland and Taylor (2001). The proximate factors identified are the scale, technique, and composition effects. The scale effect refers to when the economy grows, economic activity increases, which in turn may increase pollution levels. The technique effect refers to the reduction in the pollution intensity (pollution per unit of output) of an economy. The income effect refers to when incomes rise, assuming environmental quality is a normal good, individuals may demand better environmental quality. Consequently, tighter environmentally policy may be enacted to match the greater demand for less pollution. Also this may result in pollution-saving technology. Independent of income, technological change may also occur towards cleaner modes of production, which may reduce pollution, thus the technique effect results in a decline in pollution.

Finally there is the composition effect. An economy with a higher composition of dirty industries will have higher levels of pollution than an economy with a lower composition of dirty industries. Thus, pollution declines when an economy shifts from dirty to cleaner industries. Antweiler, Copeland, and Taylor (2001) examine how trade impacts the environment through the three proximate determinants. Their findings indicate that although trade works through the scale effect to increase pollution, the income effect outweighs all other effects, and thus trade improves the environment.

The empirical environmental literature has focused on the role of government in three ways – political economy, size of government, and more recently the composition of government spending. Empirical studies have quantified the indirect influence of government on environmental outcomes by exploring whether political variables constitute a significant part of the income effect. The central idea is that a more democratic government with less corruption is more likely to consider a policy change when consumers vote for more environmental protection. Barrett and Grady (2000) find that politically free economies perform better in reducing pollution concentrations, although political freedom does not account for all of the income effect.

The size of the government is another significant concern. There are several theories of government with a similar thread of underlying logic. Governments can act as a public good provider and a corrector of externalities, or they can be a provider of services for special interest groups, or in general provide goods and services that deviate from their citizens' preferences. Thus, one interpretation of the effect of total government expenditures on pollution would be as an indicator of whether governments provide a certain public good (pollution alleviation), or provide non-public goods (worsen pollution). Bernauer and Koubi (2006) use total government expenditures over GDP as a proxy for size and estimate its effect on SO_2 concentrations for 42 countries, from 1971 to 1996. They find that government size has a positive effect on SO_2 concentrations. One limitation of this study is that it cannot say whether this positive relationship is because governments are inefficiently providing public goods, or providing non-public goods for special interests. An examination of the composition of government expenditures would address this.

A recent study by López, Galinato, and Islam (2011) provides a theoretical foundation for the relationship between the composition of fiscal spending and environmental outcomes. Using cross country level data, the study finds that altering the composition of government spending towards social expenditures and public good expenditures reduces several air and water pollutants. As mentioned in the introduction, the present study adds to López, Galinato, and Islam (2011) by breaking the composition of government spending by the state and federal level, and then examining the impact of fiscal spending on SO2 concentrations in the US.

3. Sulfur Dioxide Sources, Regulation, and Trends

In this section I provide a brief overview of the sources of sulfur dioxide emissions and air pollution regulations. Overall sulfur dioxide emissions have been declining since 1983 (figure 1). Around two thirds of sulfur dioxide emissions stem from fuel combustion from electric power plants (Table A1). The second largest contributor is fuel combustion from industrial activities (mostly coal and oil industries). Over time, the overall contribution of fuel combustion activities towards SO2 emissions has remained fairly stable around 83%, although a decline in contribution from electric utilities have been offset by increases in fuel combustion activities. The largest increase in SO2 emissions contribution has been from Non-road vehicles and engines, a rise from 1% in 1980 to 8% in 2000 (Table A1).

Initially air pollution regulation in the United States was under state and local governments. The Clean Air Act in 1963, followed by the Air Quality Act of 1967 provided funds from the federal government to state and local governments for support and regulation of air pollution. However, the lack of enforcement and several delays in formulating standards by states led to the Clean Air Act amendments of 1970. This engendered the EPA as well as the National Ambient Air Quality Standards (NAAQS), signaling federal involvement in air pollution control in the US. National air quality standards were published for six pollutants: Sulfur oxides, particulate matter, carbon monoxide, photochemical oxides (ground level Ozone), nitrogen oxides, and hydrocarbons (mostly via Ozone standards). A big factor in the change of sulfur emissions has been the regulation of electric utilities. Coal-fired power plants built after 1978 were required to install scrubbers (flue gas desulfurization equipment) as according to the New Sources Performance Standards (NSPS) in order to reduce SO2 emissions, while power plants built before 1978 were subject to a maximum emission rate standard.

The largest piece of regulation however came in the form of the 1990 amendments of the Clean Air Act of 1970. The 1990 Amendments of the Clean Air Act involved more stringent regulation and the setting of tighter air quality standards. However, the significant piece of legislation with regards to SO2 would be the Title IV of the Clean Air Act Amendments also known as the Acid Rain Program (Carlson et. al, 2000). In order to regulate acid deposition (acid rain) a two stage emission strategy was imposed to reduce sulfur dioxide and nitrous oxides produced from electric utilities. Phase I, implemented in 1995, involved issuing allowances to power plants, which resulted in fines if exceeded. Phase II (began in 2000) imposed tighter caps on phase I plants while emission limits were imposed on cleaner smaller plants. Permits were allowed to be traded and thus the term, Cap and Trade. The impact of Title IV can be observed in figure 1 where there is a larger decline in SO2 emissions around 1994 and 1995.

Given that electric utilities are a significance source of SO2 emissions, the impact of macroeconomic policy such as government fiscal policy depends on the industrial output elasticity of both energy and electricity in the US. To elaborate, under the case of low output elasticities of energy, if a reallocation of government spending from RME to PME alters the composition of the economy towards cleaner industries at the cost of dirty industries, the impact on electricity usage by the dirty sector may be small, thus the effect on the two thirds of sulfur dioxide emissions from electric utilities may be limited. Some empirical estimates of output elasticities in the literature have been found to be close to one, or as high as 1.57 (See Table A17). Thus, we expect government spending to have an impact on energy use and hence SO2 emissions. Furthermore the fact that SO2 emissions from non-road vehicles tend not to be regulated, they may be more responsive to changes in the composition of government spending policy.

4. Conceptual Framework

In this section I provide a detailed explanation of the spending dichotomy used in this study. I then sketch out the theoretical model similar to López, Galinato, and Islam

(2011) to show the mechanisms by which the compositional shifts in government spending may affect environmental outcomes.

Spending Categories

The classification of productive and wasteful government spending is derived from López and Galinato (2007). Productive and wasteful government spending is defined by two categories – government spending on market-promoting goods (PME) and spending on market restricting goods (RME). PME spending achieves two objectives (i) alleviates the effects of market failure or (ii) increases the provision of pure public goods. Under this categorization, PME spending includes social subsidies such as education, health, social transfers, as well as expenditures in R & D, knowledge diffusion, and conventional public goods.

PME expenditures tend to complement rather than substitute private investments and also mitigate the effects of market failures, especially credit market failures, which affect a large number of households (Attanasio et. al., 2008; Grant, 2007; Jappelli 1990; Zeldes, 1989). Social subsidies specifically may alleviate liquidity constraints faced by households and therefore increase investment in education and health, which have large positive externalities but tend to be underinvested (Galor and Zeira, 1993). Similarly the private sector under-invests in R & D activities, which generate positive externalities, and also has little incentives to spend in environmental protection, which faces substantial market failures (Hoff and Stiglitz, 2000; Dasgupta, 1996)[2]. Conventional public goods, such as legal institutions including law and order are typically underinvested by the private sector, and thus government spending in such activities is merited.

RME spending usually fall under "development" or "economic affairs" expenditures that involve subsidies directly to firms for activities such as product promotion, commodity market subsidies, grants to corporations, bailouts of failed private financial institutions etc. Such expenditures typically tend to promote capital intensive industries, or substitute private investment as they are typically captured by large corporations, which are typically financially unconstrained (Slivinski, 2007). The costs and ineffectiveness of subsidies that fall under RME spending has been well documented (Coady et. al. 2006). For example the Savings and Loans crisis of the 1980s is estimated to have directly cost US taxpayers $150 billion over the period 1989-1992 (Curry and Shibut, 2000). Furthermore, the availability of RME spending tends to promote directly unproductive, profit-seeking activities (DUP) such as lobbying, by mainly special interest groups. RME spending tends to elicit more rent-seeking activities as firms are fewer than households, and can be grouped by production activity and thus can more easily solve the collective action problem (López and Islam, 2011).

Theoretical Framework

[2] There is a possibility that public R&D spending may crowd out private R&D spending. However, overall this literature is not conclusive and the results are ambiguous (David et al., 2000).

In this section I describe the theoretical model linking government spending to pollution formalized in López, Galinato, and Islam (2011). The model captures the following observations. Production pollution tends to be generated by the industrial sector, which is typically capital intensive. In contrast, service sectors and sectors that produce human capital (henceforth knowledge sector) are relatively cleaner and less capital intensive. Given the components of PME spending such as health and education, government spending in PME contributes more to the output of the clean (y_c) and knowledge (h) sectors, and contributes relatively less to the dirty sector (y_d). On the other hand Government spending in RME tends to be concentrated towards the dirty sector.

Define *g* as PME spending by the government and *x* as spending in RME (total government spending G = *x* + *g*). We make the following assumptions in the theoretical framework. First, the economy is small and trades freely in the international markets for final goods; domestic factor and output markets are perfectly competitive. Second, we assume $\eta \leq \Omega \leq \mu \leq 1$ where $\eta, \Omega,$ and μ and are the output elasticities of *g* in the dirty sector, clean sector, and knowledge sector respectively. For simplicity we assume that capital (*k)* is an input only in the dirty sector, which is a source of pollution (Z) and is a perfect substitute for government spending in RME (*x*).

The technologies of the three sectors are presented below.

(1) $$y_d = D(hl_d)^{\alpha} Z^{\beta} (x+k)^{1-\alpha-\beta} g^{\eta}$$

(2) $$y_c = Ahl_c g^{\Omega}$$

(3) $$h = Bl_r g^{\mu},$$

where l_d , l_c , l_r are labor in the dirty sector, clean, and knowledge sectors respectively (hl_i is effective labor in units of efficiency for the i^{th} sector), and α>0, β>0, $\alpha+\beta < 1$. *D, A,* and *B* are positive parameters and are the total factor productivities for the dirty, clean and knowledge sectors respectively.

Producers in the dirty sector minimize the cost of production by choosing a combination of effective labor, hl_d, and the dirty input, *Z*, given *g*, *x* and *k*. The dual cost function for the dirty sector is:

(4) $$C = \phi(\alpha+\beta)\alpha^{-1} w^{\frac{\alpha}{\alpha+\beta}} \tau^{\frac{\beta}{\alpha+\beta}} \left(x+k\right)^{\frac{\alpha+\beta-1}{\alpha+\beta}} g^{-\frac{\eta}{\alpha+\beta}} y_d^{\frac{1}{\alpha+\beta}},$$

where $\phi \equiv \mathrm{D}^{-\frac{1}{\alpha+\beta}} (\alpha/\beta)^{\frac{\beta}{\alpha+\beta}}$, *w* is the wage rate per unit of efficiency labor in the dirty sector (hl_d) and τ is the pollution tax rate. Using Shepherd's Lemma, the dirty input demand is,

(5) $$Z = \frac{\partial C}{\partial \tau} = \phi g^{-\frac{\eta}{\alpha+\beta}} (w/\tau)^{\frac{\alpha}{\alpha+\beta}} \left(x+k\right)^{\frac{\alpha+\beta-1}{\alpha+\beta}} y_d^{\frac{1}{\alpha+\beta}}.$$

The explicit expression for y_d is substituted into (5) and then logarithmically differentiated to obtain the following equation:

$$(6) \qquad \frac{d\ln Z}{d\ln g} = -\frac{\eta}{\alpha+\beta} + \frac{1}{\alpha+\beta}\frac{\partial \ln y_d}{\partial \ln g} + \frac{\alpha}{\alpha+\beta}\frac{\partial \ln w}{\partial \ln g} + \frac{(1-\alpha-\beta)}{(\alpha+\beta)}\frac{g}{k+x} - \frac{\alpha}{\alpha+\beta}\frac{d\ln \tau}{d\ln g},$$

Equation (6) shows the effect of a compositional shift of spending from RME (*x)* spending to PME (*g)* spending on pollution. Thus total government spending (*G*) is fixed.

From equation (6) we identify four partial effects of the compositional shift from RME spending to PME on pollution:

(i) *The direct effect*: As indicated by the first term in equation (6), the direct effect of an increase in g and a decrease in x is negative. This means that the same level of the dirty output can be produced with fewer dirty inputs when *g* increases holding all other factors constant. This can be attributed to R and D spending or improvements in air pollution abatement, also known as the technique effect.

(ii) *Scale Effect*: A higher g increases labor productivity, which in turn, may affect the level of the dirty output holding all other factors constant. Since a rise in g increases productivity in all sectors, a priori it is not possible to tell whether this scale effect will increase or decrease dirty sector output. If this effect causes production of the dirty output to increase (decrease), this effect will be pollution-increasing (decreasing).

(iii) *Input Composition Effects:* The third and the forth terms in equation (6) are essentially input composition effects. The third term indicates that a higher g raises the economy's wage rate, which increases pollution since labor and pollution are substitutes. The fourth terms shows that an increase in g reduces x, which implies a lower level of total capital used in production. Given a constant output level, the fall in total capital must be compensated with an increase in all variable inputs including pollution, therefore increasing pollution.

(iv) *Environmental regulation or income effect*. If public and social goods are productive, the increase in g and concomitant reduction of x may have a positive net effect on national income. This may increase the demand for regulation in the economy thus reducing pollution.

An increase in PME spending may change the composition of consumption goods, as consumption is shifted towards less polluting goods. For example, increasing PME spending may result in greater investments in public transportation, resulting in consumers altering their preferences away from private forms of transportation that are typically energy intensive, and thus reduce sulfur dioxide emissions (Shapiro et al., 2004; Zimmerman, 2005). Increasing the share of PME spending may also increase R&D promoting the consumption of more energy saving goods such as energy saving bulbs and energy saving AC and heating units etc. Moreover, human capital spending is a sizeable component of PME spending. Increases in human capital may heighten pollution awareness among the general public resulting in a decrease in pollution intensive activities (McConnell, 1997). Using household surveys in Netherlands, Ferrer-i-carbonell et al., (2004), find that increasing public awareness of pollution changes consumer expenditures towards more sustainable consumption.

The overall effect of altering the composition of spending from RME to PME will depend on which of the above effects dominate. Now I turn the issue of spending efficiency and the importance of examining fiscal policy at the federal and local levels.

Government Efficiency and Federal versus Local Spending

There are several concerns about direct inefficiency of specific government spending in achieving their targets. For instance government spending towards improving school quality may be used inefficiently and thus have limited impact in raising the quality or quantity of education. Empirically, this is less of a concern if the inefficiencies in both PME and RME spending are equivalent. This is due to the fact that impact of a reallocation of spending from RME to PME will not be debilitated if the inefficiencies of both types of spending are the same. Of course, the additional assumption is that reallocation of government spending does not affect the inefficiencies of each type of spending.

There is no reason a priori to expect the direct inefficiency of one type of spending to be larger than the other. It is likely that government assistance through either type of spending can induce strategic behavior (such as moral hazard) on the part of recipients. An example of strategic behavior would be firms or individuals refusing to move away from an environmentally hazardous area due to compensation from the government. Such compensation may come in the form of subsidies and is usually to compensate for the damages faced by individuals or firms. Along similar lines of reasoning, social subsidies such as welfare programs can be abused by similar strategic behavior.

Just as well, strategic behavior due to RME spending may incur great costs. RME subsidies tend to target specific individuals or groups, in contrast to PME spending, which benefits a larger portion of the population. Thus it is difficult for a diverse group of individuals to band together and form a sufficiently strong lobby. In other words, the diversity in the incentives of the population makes it difficult to solve the collective agency problem. As stated earlier, industries are typically located near each other and share strong interests, making it easier to form strong lobbies that promote their interests. Therefore RME spending tends to encourage greater unproductive rent-seeking activities than PME spending. This is evident with the US government's history in giving out corporate bailouts[3]. Given the potential direct inefficiencies of PME and RME spending, a priori it is difficult to say whether strategic behavior towards PME spending is more or less efficient than strategic behavioral responses to RME spending.

It is also important to note that the goal of broad fiscal policy is not necessarily to improve environmental outcomes. Thus conclusions about the efficiency of broad fiscal spending cannot be drawn from any positive or negative effect of fiscal policy on

[3] There are a few caveats however. The difficulty in forming lobby groups for public expenditures may be a virtue of the definition and classification of such expenditures. Consequently there may be lobby groups easily formed around components of government spending in public goods. Examples would be lobbying that occurs for allocation of transportation expenditures, as well as environmental protection. However, the fact that it is hard to imagine the formation of lobbies for food stamps lends credence for weaker lobbies when compared to industrial lobby groups.

environmental outcomes. The main concern is that specific inefficiencies in particular government spending programs may weaken the mechanisms by which broad fiscal policy affects environmental outcomes. However, fiscal revenues devoted towards RME spending at the expense of PME spending are an indication of allocative inefficiency. Thus we can empirically test the effect of allocative inefficiency of government spending on environment outcomes.

The impact of a compositional shift in government spending may also depend on the level of government that provides the public good. The key hypothesis is whether spending directly by federal governments, or expenditures by state expenditures have been more effective in achieving their targets. This is part of a large literature on fiscal federalism. One concern is the potential for race to the bottom scenarios when state or local government carry out fiscal policy. For instance, state governments may have disincentives to provide social programs given the open nature of their economies due to the fear that they may attract poor individuals and thus limiting their tax revenue base (Oates, 1999). Thus it is also likely that state level governments may engage in spending that is more likely to attract businesses. Competition to attract firms may induce greater RME spending and thus lead to race to the bottom scenarios. Furthermore, federal governments may have the technical expertise to carry out fiscal policy while state governments may face soft budgets in anticipation of federal bailouts. In contrast, state and local governments, being nearer to their constituencies, may be more responsive to the particular preferences and thus be able to better provide these services. Also Oates (2001) argues that in terms of environmental policy, federal government involvement should mainly entail subsidies for abatement technology, research and development, and information dissemination. The variation in efficiency by level of government may affect various spending items, which in turn may affect the environment via the mechanisms described in the conceptual model.

The dataset used in this study is able to disaggregate government spending in PME by level of delivery. For instance this study is able to distinguish between total government spending carried out at the state and local level versus spending at the federal level independent of state governments. Thus the empirical question of whether a reallocation of government spending from RME to PME at the state and local or federal level government has a larger impact on the environment is explored.

5. *Econometric Model*

The log differences in Sulfur dioxide concentrations, z_{jst}, at monitoring site j, state s, averaged over year t, are determined by the differences in the stock of PME and RME goods provided by the government[4]. This relationship is expressed in differences as reliable measures of the expenditure flows towards PME and RME exist. The annual differences of government stock are approximated by the level of corresponding government spending. We make further normalizations of the variables of interest as follows. PME_{st} is divided by total government expenditures, defining

[4] To be specific, log difference refers to the difference in the log of SO2 concentrations. Thus $z_{jst} \equiv \ln Z_{jst} - \ln Z_{jst-1}$ where Z_{jst} is SO2 concentrations at monitoring site j, state s, averaged over year t.

$g_{st} \equiv PME_{st} / Gov_{st}$. Thus instead of using PME_{st} as a separate variable, we use total government spending normalized by GDP therefore defining $G_{st} \equiv Gov_{st} / GDP_{st}$. Consistent with the literature, a 3 year moving average of personal income is used to proxy permanent income (I_{st}) (Antweiler, Copeland, and Taylor, 2001). A vector of regulations, R_{st} is controlled for.

Formally,

$$(7) \qquad z_{jst} = \gamma_1 g_{st}^{ST} + \gamma_2 g_{st}^{FD} + \gamma_3 G_{st}^{ST} + \gamma_4 G_{st}^{FD} + \gamma_5 I_{st} + \gamma_6 \mathrm{R}_{st} + \tilde{\tau}_t + v_{st} + \mu_{js} + \varepsilon_{jst}$$

Where g_{st}^{ST}, and g_{st}^{FD} are the shares of PME spending over total government spending for State and local governments, and Federal direct and indirect expenditures (loans and insurance) respectively. Accordingly, G_{st}^{ST} and G_{st}^{FD} is the share of total government spending over GDP by the state and federal level of government respectively. $\tilde{\tau}_t$ are the year effects. v_{st} is the unobserved state-specific effect, which may be fixed or time varying, μ_{js} is the unobserved site specific effect, which may be fixed or random; and ε_{jst} is an idiosyncratic error that is assumed to be independent and identically distributed with zero mean and fixed variance.

Dependant variable and main variables of interest

The dependant variable is the log difference of sulfur dioxide concentrations. The main variables of interest are share of PME spending over total spending at the state and local level and federal level. The normalization of PME spending is convenient as it yields unit free measures of the variables. As indicated earlier, total government spending over GDP is included as an explanatory variable, and thus RME spending does not need to be explicitly included in the estimation. Hence the interpretation of a negative and significant coefficient for any of the share of PME spending variables implies that a reallocation of spending from RME to PME results in a decline in the log difference of SO2 concentrations, which is the central hypothesis of this paper. One should also be careful about the interpretation of the results with regards to level of government. The level of government spending is classified according to delivery, not origination. Thus a negative significant effect of the share of PME at the state level of spending implies that a reallocation of funds from RME to PME for state level expenditures and federal expenditures carried out by the state government decreases sulfur dioxide air concentrations.

Regulation controls

There are three aspects of regulations that have to be considered in the estimations: (i) the Acid Rain Program, (ii) the ambient air quality standards specifically the assignment of counties to attainment and non-attainment status by the US Environmental Protection Agency. A non-attainment status implies that the monitoring sites recorded levels of pollutions in violation with the National Ambient Air Quality Standards (NAAQS). (iii) The degree of stringency of regulations across states that do not vary over time.

This study addresses these aspects in the following ways. (i) The Acid Rain Program (Title IV) is accounted for using fixed year effects, since this is a federal policy that applies to all states. Title IV is an important piece of legislation that has been shown to have affected sulfur dioxide emissions. For ambient air quality standards (ii), two variables are use. The first is a dummy that has a value of 1 if a whole county was under non-attainment status in the previous year. The second is also a dummy equal to one if a county was partially under nonattainment status in the previous year. Previous studies have found the NAAQS to have a significant negative but modest effect on sulfur dioxide concentrations (Greenstone, 2004). To capture state specific regulations that do not vary over time (iii), site fixed effects are used. Furthermore, the number of electricity generating power plants has hardly changed over time, and therefore this is also captured by the site level fixed effects.

Econometric issues

There are three pertinent econometric issues to be considered: reverse causality, omitted variable bias, and pollution migration across states also known as trans-boundary air pollution. Constrained by the availability of data, I show below how I do my best to limit each of the econometric issues stated above.

Reverse Causality

If sulfur dioxide concentrations are a determinant of PME spending, this would imply that PME spending is correlated with the stochastic error term, ε_{jst}, thus biasing the estimates. However, since the share of PME spending is an aggregate of several spending programs it is unlikely that broad spending policies will be determined solely by environmental concerns. Therefore, it is less likely that reverse causality is an issue. Even if fiscal spending is a forward looking variable, that is PME spending shares are determined by expected future sulfur dioxide concentrations, the correlation between PME spending and sulfur dioxide concentrations would be positive, and thus any negative effects of the share of PME spending on sulfur dioxide concentrations would be even stronger if reverse causality was accounted for.

Omitted Variable Bias

Omitted variable bias is an important issue in the specification of equation (7). If a relevant variable is omitted, it will be absorbed in the error term, which leads to biased and inconsistent estimates. Using panel estimation models such as fixed site effects will account for time invariant omitted variables. The challenging issue is time varying omitted variables. If a time varying omitted variable, such as regulation enforcement is positive correlated with the share of PME spending, but negatively correlated with Sulfur Dioxide air concentrations, then the coefficient of the share of PME spending will be biased upwards (more negative). I use the following procedures to limit the effect of omitted variables. I use the Altonji (2005) methodology, which I call the Added Controls Approach, where I control for several other variables and see whether the coefficients of interest change. I also use a new Time Varying State Effects (TVS) approach to capture state-level omitted variables that are correlated or show patterns over time (López and Palacios, 2011; López and Islam, 2011). This approach is a generalization of state fixed effects and deals with omitted variables in a rigorous and systematic way. The details of TVS approach are discussed later. Finally I provide the Arellano – Bond “system” GMM estimates.

Pollution Migration

Monitoring sites near the border of states may pick up SO2 concentrations originating from neighboring states. Similarly monitoring sites in a state may read low levels of SO2 concentrations as they are blown away to other states. This invites the possibility of spurious correlation. I account for this in three ways. First, a study by Fioletov et al. (2011) finds that the mean SO2 values near the emissions sources became insignificant in the atmosphere beyond a distance 75 km from the source, even for the largest single SO2 emitting source in their sample. As indicated in figure 11, after 75km, the SO2 values for both the largest emission source (Bowen power plant in Georgia) and 20th largest emission source (Belews Creek power plant in North Carolina) are close to zero. As shown in figure 5, most coal plants are located in the Northeast of Southern parts of the US. Thus I remove all monitoring sites that are 75 km or less from the state boundary in the Northeast and Southern states and check if the results are robust. It is important to note that while acid rain does travel far distances, none of the SO2 monitors would pick up the presence of acid disposition because its chemical composition is different from SO2 concentrations (Fioletov et al., 2011). Consequently, the issue at hand is the distance at which emissions become insignificant in the atmosphere not the distance of acid rain disposition from the source of SO2 emissions.

Second, I use the fixed effects regression model with Driscoll and Kraay standard errors that account for cross-sectional dependence in panel data. Driscoll and Kraay (1998) present a consistent covariance matrix for continuous dependent variable models with spatially dependent panel data by creating a panel data variation of the Newey and West estimators (Newey and West, 1987). This is widely used in the literature (Fleisher et al., 2010; Bun and Klassen, 2007).

Third, at the state level, I estimate spatial lag and a spatial error model using the inverse distance of the locations of the center of the highest concentration of monitoring sites across states. Thus the further away monitoring sites are located from each other, the less likely they will pick up pollution concentrations generated near other monitoring sites.

6. Data

Annual site level sulfur dioxide concentrations are obtained from the US Environment Protection Agency (EPA). The data is an unbalanced panel available from 1985 to 2008 across 50 States and Washington DC. There are about 1668 monitoring stations, and a total of 15,233 observations. Only data that was collected using a consistent methodology at the monitoring site is used. All the concentrations data used are readings taken from monitoring sites which are the maximum daily reading averaged for the full length of period in the sample. The EPA uses the maximum daily reading to set sulfur dioxide air quality standards as short exposure to sulfur dioxide concentrations has harmful health effects. Most empirical studies examining the determinants of pollutants in the US use concentrations data because emissions data is highly interpolated with emissions inventories only taken once every 3 to 5 years (Auffhammer et al., 2011, Auffhammer et al., 2009; Greenstone, 2004; Henderson, 1996).

Government spending data is obtained from the Spending Allocation Database by State (SADS) constructed by Islam (2011). This database is created by combining three different datasets, all maintained by the US Census Bureau. Each dataset provides spending data by state and differs by the level of government and spending category aggregation. The state and local level data set, known as State Government Finances, is aggregated under broadly defined categories with coverage existing from 1983 to 2008. The allocation of broad categories into PME and RME state and local spending is presented in Table A4.

For federal spending, the Consolidated Federal Funds Report (CFFR) provides disaggregation by specific program, and thus a more precise division of PME and RME spending is possible. Over 1,500 programs are identified by department, and categorized as to whether they fall under two types of PME spending - social goods, non-social public good, or under RME spending (private subsidies). Difficult to categorize spending programs are left under "other." Typically, a program description is provided in the data, or can be obtained by tracking the Catalog of Federal Domestic Assistance (CFDA) number for each program through other sources. Furthermore, each type of spending is a combination of two groups – direct spending and assistance spending. Direct spending includes grants, salaries and wages, procurement contracts, and other direct payments. Direct assistance includes direct loans, guaranteed/insured loans and insurance (see Table

A6). Assistance spending may also involve obligations. Typically de-obligations are indicated as negative amounts in CFFR. It is difficult to track, by program, when obligations were made, and how to distribute the negative amounts in prior years. Thus, negative figures are retained, and are included in the aggregate estimation of the spending type. The general categorization of each spending category by department is presented in Table A5.

Administrative expenditures appear separately in the CFFR and have to be distributed. In some cases, all the programs in a department can be identified under one category of spending. When a whole department does not fall under one category of spending, the administrative expenditures are divided by the ratio of each type of spending over total department spending. The assumption is that administrative spending is proportional to the amount of spending per type in the department. In the case of pre-1993 data, the administrative spending is not allocated by department. Thus the administrative spending is first divided by the department by the proportion of department spending over total spending. This is then further divided into the type of spending, using the proportion of the type of spending over total department spending.

Finally, there is a major potential issue of double counting – some of the CFFR expenditures are directed at states. Since CFFR does not indicate what types of spending are directed at states, a third database - Federal Aid to States (FAS) is used to limit double counting. FAS data contains amounts and details of federal grants to states, under broader categorization than the CFFR. Thus data in the FAS are split into PME and RME spending, and then subtracted from grants from the CFFR to come up with a total of federal spending net of any grants to state and local governments. All federal datasets have time coverage of 1985-2008.

To summarize, government spending data are available at the state and local level, federal direct spending net grants to states, and federal assistance (indirect) spending. Summary statistics of government spending variables and other controls are available in Table A2. Data description, sources and time coverage are presented in Table A3.

7. Results and Robustness

Results

Table 1 presents the OLS, fixed, and random site effects estimates in columns 1, 2 and 3 respectively. The Huber/White/Sandwich estimator of variance is used to estimate the standard errors to account for heteroskedasticity. All estimates yield negative coefficients for the share of PME spending at the state and local level of government, significant at 1%. The coefficients for the share of PME spending at the state level range between -0.25 to -0.47[5]. The share of PME spending at the federal level of government is insignificant. Total government spending is not robust across the estimates for either state or federal levels of government.

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[5] Some of the effects of PME spending may take a large period of time to have an effect. The estimates in Table 1 were repeated using 3 year moving averages of the spending variable. The results in Table 1 were largely retained.

The coefficient for personal income is consistent with the literature, yielding a negative coefficient significant at 1% across all estimation models. This implies a strong income effect with regards to sulfur dioxide air concentrations. Both non-attainment status variables for sulfur dioxide are negative, but only the counties which partially had non-attainment status in the previous year resulted in a statistically significant reduction in SO2, with a level of significant of 1%. This implication maybe that counties that were partially under non-attainment status in the previous year may have enforced stricter sulfur dioxide regulations in order to remove the non-attainment status.

As discussed earlier. The share of PME spending is unlikely to be affected by reverse causality. However, the issue of omitted variable bias persists. As stated earlier, fixed site effects addresses the issue of time-invariant omitted variables, however I still have the issue of time varying omitted variables. To address this, I use two approaches as part of the sensitivity analysis – the added controls approach, and the TVC approach.

Added Controls Approach

Studies have shown that several factors may directly or indirectly affect environmental quality. Factors such as economic intensity (Antweiler et al., 2001; Grossman and Kruger, 1995; Harbaugh et al., 2002), sector composition (Brooks and Sethi, 1997; Antweiler et al, 2001), socioeconomic characteristics such as racial composition and economic conditions (Brooks and Sethi, 1997; Khanna, 2002) have all been determinants of environmental quality. In addition, pollution abatement costs may influence firms' decisions to pollute and this may influence environmental quality (Levinson , 1996;

Levinson and Taylor, 2008). Since electric utilities contribute about two thirds of sulfur dioxide emissions, total net generation of electricity may be an important control variable for the specification in equation (7). Price of natural gas or fuel may influence activities that emit SO2. Several meteorological factors may also affect air quality such as wind speed and direction, temperature, height of monitoring site probe, and elevation above sea level. Finally, pollution readings in a state can be correlated by the no. of monitoring sites in the state. I add a set of variables representing each of the determinants listed above in sequence into the random and fixed site effect estimations in Table 1 to test the robustness of the variables of interest. Some of these controls are interpolated due to sparse data. Pollution abatement costs data is linearly imputed for the years 1987, 1995-1998, 2000-2004, and racial composition data from the census is linearly imputed for the years 1981-1989, 1991-1999. The meteorological data is obtained from a few sites that have the data, and assumed to be representative of the whole state.

Table 2 shows the coefficients of the effect of PME spending for state and local governments as each set of controls are added. An increase in the adjusted R-squared relative to the base estimations implies that including the additional sets of controls raises the explanatory power of the model. If the coefficient of PME spending retains the sign and significance, this implies that the coefficient is stable and robust to the additional regressors.

Table 2 shows that the coefficients of PME spending are largely unaffected by the additional sets of control variables. Both the sign and significance of the PME spending coefficient is negative and has a significant of at least 5%. Racial composition proxies, and meteorological conditions all raise the adjusted R squared of the random site effects model, while there is no improvement in the adjusted R squared for the fixed site effects model. Considering the potential controls presented in Table 2, I can conclude that the results are robust to omitted variables that are correlated with these sets of variables. However, there may be factors that I cannot proxy or are ignorant about, and thus the issue omitted variables is not completely accounted for. I use the Time Varying State Effects (TVS) approach, as described in the next section, to mitigate the biases of difficult to measure determinants of air pollution.

Time Varying State Effects (TVS)

The estimations in Table 1 are subject to omitted variable bias due to the state level factors that may be omitted because they are difficult to measure or our ignorance about other potential determinants of sulfur dioxide concentrations. Thus, I introduce time-varying state-specific effects (TVS). This methodology has been previously used by López and Palacios (2011) and López and Islam (2011).

Reconsider equation (7) where v_{st} is the unobserved state-specific effect, which may be fixed or time varying. This v_{st} effect in (7) corresponds to the TVS, which is a state specific function of time that captures the effects of certain state level omitted variables on the pollutant. Potential important control variables, for example state macroeconomic policies, regulatory and political institutions and so forth, follow certain patterns that tend to change over time. This may be non-linear, but not always monotonically, and potentially in a state-specific manner. The evolution of such policies and institutions may display some correlation with time. Thus such omitted control variables may be adequately captured by polynomial functions of time. I approximate the v_{st} effect by a (T-2)th order (state specific) polynomial function of time, where the parameters are allowed to take different values for each state as shown below:

(8) $$v_{st} = b_{0s} + b_{1s}(trnd) + b_{2s}(trnd)^2 + b_{3s}(trnd)^3 + ... + b_{T-2s}(trnd)^{T-2} + e_{st}$$

Where $b_{0s}, b_{1s}, b_{2s}, b_{3s}, ... b_{T-2,s}$ are coefficients that are allowed to be different for each state and $trnd$ is a time trend variable. The coefficients b_{0s} correspond to the fixed state effects and the remaining coefficients capture the state specific time-varying effects.

Substituting (8) into (7) I obtain the estimating equation with new disturbance term $\tilde{\varepsilon}_{jst} = \varepsilon_{jst} + e_{st}$. I assume the polynomial in equation (8) is an exact approximation of v_{st}, and thus the residual of the polynomial approximation, e_{st}, is assumed to be random and independent of time, an assumption that is empirically tested. One could fully control for all the v_{st} effects by using the complete matrix of state-year dummies but of course this would leave no degrees of freedom to estimate the effect of any other variable. However, if I assume that the unobserved effects are not completely time independent, a (T-2)th polynomial may be sufficiently flexible to capture the unobserved effects while still permitting the estimation of the effects of observed variables.

The TVS is a generalization of the standard fixed state effects model as the fixed state effects correspond to the b_{0i} coefficients in (8). Thus the standard state fixed effects can be regarded as a special case where (8) is restricted by imposing that all coefficients other than the constants be zero. Thus I can also I can test the validity of the state fixed effects model parametrically by imposing the following restrictions: $b_{1s} = b_{2s} = ... = b_{T-2s} = 0$ for all $s \in \{1, 2, ..., S\}$ while $b_{0s} \neq 0$, for all or some s.

The TVS estimation model is related to estimations present in the literature (Cornwell et al., 1990; Jacobsen et al., 1993; Friedberg, 1998; and Wolfers, 2006). These studies choose up to a quadratic function of time in order to capture individual or state-specific slow moving omitted variables, not really justifying why a quadratic function is adequate for the estimation. The main advantage of the TVS model proposed here over similar estimations in the literature is that the data defines the limit of the time trend polynomial consistent with the degrees of freedom in the data.[6]

Table 3 presents the TVS-RSE model where I include both random site level effects and time varying state level effects. Since the lowest number of observations per state is 6, only up to the 4th polynomial is necessary to approximate v_{st} [7]. However, just to check for consistency, I provide estimates up to the 5th polynomial. The estimation with only a

[6] A related estimation method is the interactive effects (Bai, 2009; Kneip, Sickles, and Song, 2012). If the state specific unobserved heterogeneity in the data can indeed be explained by the TVS effects, then the TVS estimation model is more efficient than the interactive effects (Kim and Oka, 2012).
[7] The low number of observations for some states is due to the fact that only monitoring sites with a consistent methodology in terms of length of time of the exposure are included in the study

linear approximation of v_{st} is shown in column 1, while column 2 shows the squared approximation, and so on until up to the 5th polynomial approximation in column 5.

Using the 4th polynomial approximation of v_{st}, the share of PME spending at the state and local level retains the sign and significance at 5% while federal PME spending remains insignificant. The size of the coefficient of the former is larger than OLS, random, and fixed site effects reported in table. The sign and significance of personal income is retained at 1%, while total government spending is positive and non-significant for both state and federal levels of government. The attainment status variable for partial counties retains the negative sign and a significance of 5%.

The TVS-RSE residuals as indicated in Table 3 are time independent[8]. The log likelihood ratio test favors the TVS-RSE model over using state level fixed effects at the 1% level of significance. I also estimated the TVS-FSE model as indicated in Table A11. Although the results are qualitatively similar to the TVS-RSE model, the residuals are generally not time independent.

Magnitude of Effects

The elasticities of PME spending for state and local governments with respect to sulfur dioxide concentrations are presented in Table 4. Using the fixed and random effects estimates in Table 1 and the TVS-RE estimates in Table 3, a 10 % increase in the share of

[8] The p-values presented at the bottom of table 3 test the time independence of the residual using the estimation $\tilde{\varepsilon}_{jst} = \text{constant} + \beta trend$

PME spending reduces sulfur dioxide concentrations by 4%, 3%, and 5% respectively for state and local governments. The magnitude of all the effects has a significance of at least 1% apart from the TVS-RSE estimates which have a significance of 5%. This is a significant effect since sulfur dioxide concentrations have been falling at an annual average rate of 5% from 1980 to 2008. The results are consistent with the findings of Lopez, Galinato and Islam (2011) who find that the share of PME spending has a negative effect on air and water pollution.

Robustness Checks: Extreme Observation Dominance

A small number of outlier observations may be driving the results. In order to address this, I drop the top 1%, the bottom 1%, and both top 1% and bottom 1% observations of the dependent variable (log difference of sulfur dioxide concentrations) and the variable of interest (PME spending for the state and local government) and re-estimate the fixed and random state effects estimations in Table 1 and the TVS-RSE estimations in Table 2. The results are presented in Table A7, A8 and A9 for fixed site effects, random site effects, and TVS-RSE respectively. The signs of the coefficients for PME spending for the state and local levels of government are negative and have at least a 10% level of significance for all the sample alterations for random site effects and fixed site effects. This is also true for TVS-RSE estimates. Thus extreme or outlier observations do not dominate the results for state and local PME expenditures.

Robustness Check: State Dominance

I also consider the possibility that the results may be driven by a particular state. Thus, I drop each state, one at a go, and re-estimate the fixed and random site effects models in Table 1. Figures 2 and 3 present the coefficients of PME spending at the state and local level for the fixed and random site level estimation models and the 95% confidence interval. As indicated in the graphs, the sign and significance of PME spending at the state and local level is robust and not dominated by any one particular state in the sample.

Robustness Check: Specification

As a further robustness check, I estimated a dynamic panel model using the Arellano-Bond two-step procedure "System" Generalized Method of Moments (GMM). The GMM estimation accounts for inertia that may exist in the determination of sulfur dioxide concentrations and also uses predetermined values as instruments in a systematic way. The estimates are presented in Table A10. The first column uses un-collapsed instruments, and the second column presents collapsed instruments. The seventh lag of endogenous variables used as instruments. The sign and significance of the coefficients of PME spending at the state and local level of government is retained. The lagged dependent variable is insignificant implying that there are no significant dynamic effects. The Hansen test indicates that the instruments are exogenous and there is also no second order autocorrelation.

Robustness Check: Pollution Migration

The estimates in Table 1 are repeated in table A12 with all sites a distance of 75 km or below from the state border omitted for the northeast and southern regions of the US. Thus the monitoring site count drops from 1668 to 1109. However, as shown in table A12, the sign of the share of PME for the state and local levels of government is retained with at least a 10% significance level, indicating that pollution migration may not be a significant factor. A further comparison between Table 1 and A12 reveals that excluding sites closer to the state border results in estimates of higher magnitude for State and local PME spending for all estimation models. It is difficult know whether to attribute these changes in magnitude and significance to air pollution migration or the decline in the number of observations. Table A13 uses the Driscoll-Kraay estimator for fixed effects and the results for the PME spending variables are retained assuming autocorrelation up to 6 levels of lags. The results for sate and local PME spending retain sign and significance Thus the results in this study may be robust to the possibility of cross-sectional spatial dependence.

Finally, using the average GPS coordinates of each monitoring site over the whole state, a spatial lag and spatial error model is estimated using an inverse distance weighting matrix. The results are presented in Table A14 and show that the share of PME spending for the state and local level retain significance of about 5%. Both the spatial lag and spatial autocorrelation terms are insignificant. This may imply that spatial aspect of sulfur dioxide concentrations is less critical when examining the whole of the US.

Robustness Check: Structural Change across Regions

Given that very few coal-fired electric utilities are located in the West and Midwest regions of the US, there is a possibility that the share of PME spending at the state and local level may have no impact in these regions. Using the chow test to test for structural change for these regions (see p-values in Table A15) we find that there is no difference in the effect of the share of PME spending by state and local governments in the Western region from the base estimations. However at the 10% level of significance, we reject that the Midwest region has parameter estimates equal to the base regressions. Re-estimations of the RE and FE models for the Midwest region alone retains the sign and significance of the share of PME spending for state and local governments.

8. Conclusion

This paper examines the effect of the composition of government spending at various levels of government on the sulfur dioxide air pollution in the US. A reallocation of government spending from private subsidies (RME) to social spending that alleviates market failures and increases public goods (PME), holding total government spending fixed, results in significant reductions in the log difference of sulfur dioxide concentrations for state and local governments but not the federal government. After subjecting the results to rigorous tests that limit the affect of omitted variable bias and also sensitivity to sample alterations, I find that the effect state and local PME spending is robust. The results are consistent with the findings of Lopez, Galinato and Islam (2011) who find a negative effect of a reallocation from RME to PME spending on air and water pollutants. Also, similar to the literature, the effect of personal income on the log difference of sulfur dioxide concentrations is robust.

In the light of the present economic circumstances, this study is a timely addition to the debate on US government spending priorities. While the effect of total government spending is neutral, the reductions of sulfur dioxide air pollution by increasing the share PME spending may imply that reductions in US state government spending under huge budget deficits should be taken with care. Even though the main goal of fiscal policy is not to alleviate environmental concerns, it is important to consider the effects they may have on the environment, potentially affecting the impact of existing and potentially costly environmental regulations.

There are a few limitations of this study that can be addressed by future research. A study of the effect of tax expenditures, or expenditures via tax breaks, on pollutants may complement this study that focuses on revenue expenditures. Furthermore, the issue of pollution migration can be more rigorously explores using a site-level spatial analysis.

Tables And Figures

Table 1: Log Difference of SO2 and Fiscal Spending

	OLS	Fixed Site Effects (FSE)	Random Site Effects (RSE)
Share of PME over Total Spending – State and Local Governments	-0.248*** [0.079]	-0.472*** [0.154]	-0.364*** [0.127]
Share of PME over Total Spending –Federal Grants, Expenditure, Loans and Insurance	0.027 [0.038]	-0.022 [0.077]	0.004 [0.064]
Total State and Local Government Spending over GDP	-0.175 [0.132]	-0.394 [0.296]	-0.361 [0.242]
Total Federal Government Spending over GDP)	-0.02 [0.034]	-0.187** [0.093]	-0.061 [0.068]
Personal Income per Capita by County – log difference of 3 year moving average (in thousands)	-0.390*** [0.125]	-0.449*** [0.144]	-0.433*** [0.131]
Non-attainment Status for the whole county for the Previous Year (SO2 NAAQs)	-0.028 [0.022]	-0.006 [0.028]	-0.024 [0.029]
Non-attainment Status for part of county for the Previous Year (SO2 NAAQs)	-0.028*** [0.009]	-0.023* [0.013]	-0.032** [0.016]
Latitude of site	0.0003 [0.001]		-0.0002 [0.002]
Longitude of site	0.001** [0.000]		0.001** [0.001]
Site characteristics and land use dummies	Yes	No	Yes
Year Effects	Yes	Yes	Yes
Adjusted R^2	0.03	0.03	0.03
Number of Observations	15233	15233	15233
Number of sites	1668	1668	1668

* significant at 10%; ** significant at 5%; *** significant at 1%, Robust standard errors used, Site characteristics include Rural, Suburban, Urban and City Center. Land Use dummies include Agricultural. Commercial, Desert, Forest, Industrial, Military Reservation. Mobile, and Residential

Table 2: Added Controls Approach

	Fixed Site Effects (FSE)		Random Site Effects (RSE)	
	Coefficient of Share of PME by State and Local Governments	Adjusted R squared	Coefficient of Share of PME by State and Local Governments	Adjusted R squared
Base	-0.472*** [0.154]	0.03	-0.364*** [0.127]	0.03
Economic Intensity GDP per Land (sq km), GDP growth, Population Density	-0.488*** [0.154]	0.03	-0.368*** [0.128]	0.02
Sector Composition Share of Manufacturing over GDP Employment in Manufacturing	-0.473*** [0.157]	0.03	-0.356*** [0.129]	0.02
Economic Conditions Unemployment Rate Poverty Rate	-0.471*** [0.155]	0.03	-0.354*** [0.128]	0.03
Pollution Abatement Costs Capital Costs lagged Operating Costs lagged	-0.341** [0.156]	0.03	-0.320** [0.137]	0.03
Racial Composition % white, % black	-0.444** [0.184]	0.04	-0.397*** [0.138]	0.03
Fuel Prices (log difference) Natural gas, Diesel	-0.505*** [0.154]	0.03	-0.393*** [0.127]	0.03
Monitoring Sites No. of Monitoring Sites	-0.452*** [0.155]	0.03	-0.373*** [0.128]	0.03
Wind Speed and Direction Average Wind Speed, Wind Direction	-0.318** [0.154]	0.03	-0.265** [0.133]	0.03
Temperature and Geographical Conditions Temperature, Elevation Above Sea Level, Height of Monitoring Site Probe	-0.462*** [0.171]	0.04	-0.328** [0.153]	0.03
Electricity Production Total Net Generation of Electricity	-0.474*** [0.179]	0.03	-0.417*** [0.140]	0.03

* significant at 10%; ** significant at 5%; *** significant at 1%, Robust standard errors used

Table 3: Log Difference of SO2 and Fiscal Spending Variable State - Random Site Effects – TVS-RSE

Share of PME over Total Spending –State and Local Governments	-0.466** [0.197]	-0.454** [0.219]	-0.444* [0.242]	-0.599** [0.248]	-0.634** [0.251]
Share of PME over Total Spending – Federal Grants, Expenditure, Loans and Insurance	-0.092 [0.107]	-0.097 [0.136]	-0.155 [0.140]	-0.065 [0.154]	-0.337** [0.156]
Total State and Local Government Spending over GDP	-0.572 [0.356]	-0.502 [0.403]	-0.691 [0.439]	-0.685 [0.461]	-0.208 [0.508]
Total Federal Government Spending over GDP	-0.077 [0.187]	-0.113 [0.202]	-0.097 [0.217]	-0.16 [0.240]	0.114 [0.257]
Personal Income per Capita by County – log difference of 3 year moving average (in thousands)	-0.459*** [0.133]	-0.465*** [0.135]	-0.480*** [0.138]	-0.467*** [0.140]	-0.464*** [0.141]
Non-attainment Status for the whole county for the Previous Year (SO2 NAAQs)	-0.022 [0.029]	-0.018 [0.028]	-0.022 [0.027]	-0.023 [0.028]	-0.025 [0.027]
Non-attainment Status for part of county for the Previous Year (SO2 NAAQs)	-0.035** [0.016]	-0.033** [0.016]	-0.036** [0.016]	-0.033** [0.016]	-0.035** [0.016]
State Dummy x (Time Trend)	Yes	Yes	Yes	Yes	Yes
State Dummy x $(\text{Time Trend})^2$	No	Yes	Yes	Yes	Yes
State Dummy x $(\text{Time Trend})^3$	No	No	Yes	Yes	Yes
State Dummy x $(\text{Time Trend})^4$	No	No	No	Yes	Yes
State Dummy x $(\text{Time Trend})^5$	No	No	No	No	Yes
Site characteristics and land use dummies	Yes	Yes	Yes	Yes	Yes
Year Effects	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.03	0.03	0.03	0.04	0.04
Number of Observations	15233	15233	15233	15233	15233
Number of sites	1668	1668	1668	1668	1668
Specification Tests					
Test for the time	0.9970	0.9751	0.9861	0.9801	0.9836

independence of the residuals: p-values					
Correlation coefficient between the residuals and time trend	0.000	-0.0003	-0.0001	-0.0002	-0.0002
Test for fixed site effect model Ho: $b_{1i} = b_{2i} = b_{3i} = 0$. Log Likelihood Ratio Test	110***	183***	250***	353***	429***
* significant at 10%; ** significant at 5%; *** significant at 1%, Robust standard errors used					

Table 4: Magnitude of Effects

	Elasticity of SO2 concentrations with respect to the Share of PME over Total Spending by State and Local Governments (evaluated at the sample means)		
	Fixed Site Effects	Random Site Effects	Variable State Random Site Effects (TVS-RE)
1% increase in PME spending	-0.39%***	-0.30%***	-0.49%**

* significant at 10%; ** significant at 5%; *** significant at 1%

Table A1: Sources of SO_2 Emissions

	1980	1985	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
TOTAL -All Sources (Millions short Tons)	26	24	23	24	23	23	22	22	19	19	20	20	19	18
SOURCES (%)														
Electric Utilities: Fuel Combustion	67	69	70	67	68	68	68	68	63	65	66	67	65	63
Residential and Commercial Activities: Fuel Combustion (excluding Industrial Activities and Electric Utilities)	4	2	3	4	3	3	3	4	4	3	3	3	3	3
Industry: Processes and Fuel Combustion (% of Total)	26	23	22	23	22	22	23	23	25	22	21	21	21	23
Transportation (% of Total)														
On-Road Vehicles	2	2	2	2	2	3	2	1	2	2	2	2	2	2
Non-Road Engines and Vehicles	1	3	3	4	4	4	4	5	5	7	7	7	8	8

Source: National Air Quality and Emissions Report, 2003 (EPA)

Table A2: Summary Statistics

	Mean	Standard Deviation	Min	Max	Unit
Sulfur Dioxide	19.37	16.01	0.00932	222.9	Parts Per Billion (PBM)
Share of PME over Total Spending –State and Local Governments	0.820	0.042	0.582	0.933	Fraction over total state expenditures
Share of PME over Total Spending – Direct and Indirect Federal Expenditures	0.788	0.098	0.185	0.945	Fraction over total federal grants not via states
Total State and Local Government Spending over GDP	0.176	0.030	0.084	0.300	Fraction over total Federal Loans and Insurance
Total Federal Government Spending over GDP	0.245	0.106	0.140	0.846	Fraction Over GDP
County Personal Income per Capita by (in thousands)	23,674	9.419	6,665	118,768	Per capita, USD
Latitude	38.902	4.840	19.204	60.695	Degrees
Longitude	-89.576	15.045	-158.133	-67.401	Degrees
GDP per Land (sq km)	8,362,759	40,800,000	33,536	1,580,000,000	Per Square km (land)
GDP growth	0.057	0.040	-0.310	1.290	Log difference of GDP
Population Density	233	485	0.951	10,391	Per Square km (land)
Share of Manufacturing over GDP	0.177	0.072	0.002	0.333	Proportion
Employment in Manufacturing	615,703	498,052	2,017	2,222,373	Number employed
Unemployment Rate	5.617	1.561	2.240	13.430	Percentage
Poverty Rate	12.902	3.316	2.900	27.200	Percentage
Pollution Abatement Capital Expenditures	190.360	224.952	0.000	1699.00	Millions of dollars
Pollution Abatement Operating Costs	547.648	468.320	4.900	2622.80	Millions of dollars
Proportion white	0.833	0.092	0.258	0.986	Proportion
Proportion black	0.108	0.074	0.003	0.658	Proportion
Average Wind Speed	5.117	1.474	0.336	24.483	Knots
Average Wind Direction	191.223	14.508	47.243	225.988	Degrees
Temperature	55.33	10.733	25.641	133.377	Fahrenheit

Elevation Above Sea Level	252.788	364.268	0	5040	Meters
Site Prove Height	5.130	4.288	1	152	Meters
Price of Natural Gas	5.646	2.272	1.243	27.540	Dollars per million Btu
Price of Diesel	10.059	4.647	5.743	29.505	Dollars per million Btu
Net Total Electricity Production	112,214	75,342	37	405,492	Megawatt Hours in millions

Table A3: Data Source And Time Periods

Variable name	Definition	Years Available	Data Source
Sulfur Dioxide	Sulfur Dioxide concentrations by monitoring site (Daily Hourly Maximum)	1980-2009	US Environmental Protection Agency (EPA)
Share of PME over Total Spending –State and Local Governments	US government spending on PME by states. Any federal spending to states are included here	1983-2008	US Census Bureau, State Government Finances
Share of PME over Total Spending – Direct and Indirect Federal Expenditures	US government spending on PME directly through federal grants and expenditures and federal loans and insurance. This excludes any federal grants to states.	1983-2008	US Census Bureau, Consolidated Federal Funds Report (CFFR), Federal Aid to States (FAS)
Total State and Local Government Spending over GDP	Total State and Local government spending over GDP	1983-2008	US Census Bureau, Consolidated Federal Funds Report (CFFR)
Total Federal Government Spending over GDP	Total Federal spending, including loans and insurance over GDP	1983-2008	US Census Bureau Consolidated Federal Funds Report (CFFR), Federal Aid to States (FAS)
Personal Income per Capita by County – log difference of 3 year moving average (in thousands)		1980-2008	US Census Bureau
Non-attainment Status for the whole county for the Previous Year (SO2 NAAQs)	Dummy is 1 if the whole county was under non-attainment status in the previous year	1978-2011	US Environmental Protection Agency (EPA)
Non-attainment Status for part of county for the Previous Year (SO2 NAAQs)	Dummy is 1 if the part of the county was under non-attainment status in the previous year	1978-2011	US Environmental Protection Agency (EPA)
Latitude		1980-2009	US Environmental Protection Agency (EPA)
Longitude		1980-2009	US Environmental Protection Agency (EPA)
GDP per Land (sq km)		1980-2009	Bureau of Economic Analysis (BEA)
GDP growth		1980-2009	Bureau of Economic Analysis (BEA)
Population Density		1980-2009	US Census Bureau, State Government Finances
Share of Manufacturing over GDP		1980-2008	Bureau of Economic Analysis (BEA)

Employment in Manufacturing		1980-2008	Bureau of Economic Analysis (BEA)
Unemployment Rate		1980-2010	Bureau of Labor Statistics
Poverty Rate		1980-2009	U.S. Bureau of the Census, Current Population Survey, Annual Social and Economic Supplements
Pollution Abatement Capital Expenditures	Expenditures by manufacturing establishments collected via surveys. Years 1987, 1995-1998, 2000-2004 are linearly imputed	1980-1986,1988-1994,1999, 2005)	US Department of Commerce, EPA
Pollution Abatement Operating Costs	Expenditures by manufacturing establishments collected via surveys. Years 1987, 1995-1998, 2000-2004 are linearly imputed	1980-1986,1988-1994,1999, 2005)	US Department of Commerce, EPA
Proportion white	1981-1989, 1991-1999 data linearly imputed	1980, 1990, 2000-2009	Population Division, US Census Bureau
Proportion black	1981-1989, 1991-1999 data linearly imputed	1980, 1990, 2000-2009	Population Division, US Census Bureau
Average Wind Speed	Wind speed averaged over sites with wind speed readings by state	1980-2009	US Environmental Protection Agency (EPA)
Average Wind Direction	Wind direction averaged over sites with wind direction readings by state	1980-2009	US Environmental Protection Agency (EPA)
Temperature	Temperature averaged over sites with temperature readings by state	1980-2009	US Environmental Protection Agency (EPA)
Elevation Above Sea Level	The elevation (in meters) above the Mean Sea Level (MSL) of the site	1980-2009	US Environmental Protection Agency (EPA)
Site Prove Height	Height of Monitoring Site Probe	1980-2009	US Environmental Protection Agency (EPA)
Price of Natural Gas	Natural gas average price, all sectors (including supplemental gaseous fuels). Dollars per million Btu	1980-2009	U.S. Bureau of the Census
Price of Diesel	Distillate fuel oil price in the transportation sector (diesel). Dollars per million Btu	1980-2009	U.S. Bureau of the Census
Total Net Generation of Electricity	Total Net generation of electricity by state in billions of megawatt hours	1990-2010	US Energy Information Administration (EIA)

Table A4: State and Local Spending Type Classification

Department	Spending Classification
Education Health: (Includes Environmental Protection) Social Security and Welfare: Housing and Community Development:	Social Goods (PME)
Public Order and Safety Transportation and Sanitation Parks, Recreation, and Libraries	Public Goods – Non social (PME)
Economic Affairs Utilities Liquor Stores	Private Subsidies (RME)
Un-allocable Government Expenditures Government Administration Insurance Trusts Other (Veteran's bonuses and services, parking facilities)	Other

Table A5: Federal Spending Type Classification

Department	Spending Classification
Social Security Administration Health and Human Services Education Housing and Urban Development National Science Foundation Office of Personnel Management	Social Goods (PME)
Corps of Engineers Judicial Branch Legislative Branch Environmental Protection Agency Justice National Aeronautics and Space Administration Homeland Security	Public Goods – Non social (PME)
Executive Office of the President Defense-Military Veteran Affairs General Services Administration	Other
Agriculture Commerce Energy Interior Labor Small Business Administration Transportation Treasury State and Other International Programs Other Independent Agencies	Mixed (Private, Social, Public Goods and other subsidies)

Table A6: Federal Direct Spending and Assistance Classification

Direct Spending	Assistance
Grants (Block, Formula, Project, and Cooperative Agreements) Salaries and Wages Procurement Contracts Retirement and Disability Payments for Individuals Other Direct Payments for Individuals Direct Payments Other than for Individuals	Direct Loans Guaranteed/Insured Loans Insurance

Table A7: Robustness Check – Extreme Observation Dominance
Fixed Site Effects

Dominance Test	Share of PME goods over Total Spending by State and Local Governments		
	Bottom 1% Dropped	Top 1% Dropped	Top 1% & Bottom 5% Dropped
Observations Dropped of Log Difference of Sulfur Dioxide Concentrations	-0.390*** [0.125]	-0.287* [0.160]	-0.227* [0.124]
Observations Dropped of Share of PME spending - State and Local Governments	-0.475*** [0.155]	-0.704*** [0.207]	-0.728*** [0.204]

Significant at *10%; ** 5%; *** 1%, Robust standard errors used

Table A8: Robustness Check – Extreme Observation Dominance
Random Site Effects

Dominance Test	Share of PME goods over Total Spending by State and Local Governments		
	Bottom 1% Dropped	Top 1% Dropped	Top 1% & Bottom 5% Dropped
Observations Dropped of Sulfur Dioxide Concentrations	-0.375*** [0.100]	-0.224* [0.115]	-0.224*** [0.077]
Observations Dropped of Share of PME spending - State and Local Governments	-0.298** [0.136]	-0.437*** [0.145]	-0.371** [0.158]

Significant at *10%; ** 5%; *** 1%, Robust standard errors used

Table A9: Robustness Check – Extreme Observation Dominance Variable State - Random Site Effects (TVS-RSE)

Dominance Test	Share of PME goods over Total Spending by State and Local Governments		
	Bottom 1% Dropped	Top 1% Dropped	Top 1% & Bottom 5% Dropped
Observations Dropped of Sulfur Dioxide Concentrations	-0.450** [0.209]	-0.410* [0.220]	-0.313* [0.187]
Observations Dropped of Share of PME spending - State and Local Governments	-0.589** [0.238]	-1.130*** [0.396]	-1.129*** [0.377]

Significant at *10%; ** 5%; *** 1%, Robust standard errors used

Table A10: System GMM Estimator

	GMM – Un-collapsed Instruments	GMM – Collapsed Instruments
Share of PME over Total Spending – State and Local Governments	-0.237** [0.093]	-0.286*** [0.093]
Share of PME over Total Spending – Federal Grants, Expenditure, Loans and Insurance	-0.004 [0.034]	0.013 [0.045]
Total State and Local Government Spending over GDP	-0.119 [0.136]	-0.219 [0.221]
Total Federal Government Spending over GDP)	-0.060** [0.027]	-0.051* [0.031]
Personal Income per Capita by County – log difference of 3 year moving average (in thousands)	-0.419** [0.173]	-0.291 [0.193]
Non-attainment Status for the whole county for the Previous Year (SO2 NAAQs)	-0.023 [0.019]	-0.035 [0.024]
Non-attainment Status for part of county for the Previous Year (SO2 NAAQs)	-0.025** [0.010]	-0.037*** [0.013]
Latitude of site	-0.001 [0.001]	0.0001 [0.001]
Longitude of site	0.001*** [0.000]	0.001** [0.000]
Log difference of SO2 (lagged)	-0.095 [0.244]	-0.486 [0.541]
Site characteristics and land use dummies	Yes	Yes
Year Effects	Yes	Yes
Hansen Test (P- value)	0.231	0.963
Arellano-Bond test for AR(1)	0.051	0.658
Arellano-Bond test for AR(2)	0.973	0.466
Number of Observations	14360	14360
Number of sites	1514	1514

* significant at 10%; ** significant at 5%; *** significant at 1%. Two-step covariance matrix derived by Windmeijer (2005) used with finite-sample correction. Sixth lag of endogenous variables used as instruments.

Table A11: Log Difference of SO2 and Fiscal Spending Variable State - Fixed Site Effects – TVS-FSE

Share of PME over Total Spending –State and Local Governments	-0.526***	-0.491**	-0.479**	-0.588**	-0.628**
	[0.190]	[0.203]	[0.228]	[0.241]	[0.255]
Share of PME over Total Spending –Federal Grants, Expenditure, Loans and Insurance	-0.11	-0.14	-0.18	-0.101	-0.336**
	[0.101]	[0.126]	[0.133]	[0.143]	[0.160]
Total State and Local Government Spending over GDP	-0.445	-0.456	-0.61	-0.651	-0.157
	[0.347]	[0.386]	[0.443]	[0.476]	[0.510]
Total Federal Government Spending over GDP	-0.177	-0.189	-0.147	-0.178	0.126
	[0.200]	[0.216]	[0.228]	[0.285]	[0.297]
Personal Income per Capita by County – log difference of 3 year moving average (in thousands)	-0.459***	-0.459***	-0.452***	-0.435***	-0.436***
	[0.145]	[0.149]	[0.152]	[0.156]	[0.158]
Non-attainment Status for the whole county for the Previous Year (SO2 NAAQs)	-0.012	0.003	-0.002	-0.003	-0.003
	[0.035]	[0.037]	[0.036]	[0.038]	[0.039]
Non-attainment Status for part of county for the Previous Year (SO2 NAAQs)	-0.029**	-0.021	-0.025*	-0.021	-0.026*
	[0.013]	[0.013]	[0.013]	[0.013]	[0.014]
State Dummy x (Time Trend)	Yes	Yes	Yes	Yes	Yes
State Dummy x (Time Trend) ^{2}	No	Yes	Yes	Yes	Yes
State Dummy x (Time Trend) ^{3}	No	No	Yes	Yes	Yes
State Dummy x (Time Trend) ^{4}	No	No	No	Yes	Yes
State Dummy x (Time Trend) ^{5}	No	No	No	No	Yes
Site characteristics and land use dummies	Yes	Yes	Yes	Yes	Yes
Year Effects	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.03	0.03	0.03	0.04	0.04
Number of Observations	15233	15233	15233	15233	15233
Number of sites	1668	1668	1668	1668	1668
Specification Tests					
Test for the time independence of the residuals: p-values	0.5285	0.0000	0.0003	0.0000	0.0000
Correlation coefficient between the residuals and time trend	0.0051	-0.0421	-0.0295	0.0384	0.0460
Test for fixed site effect model Ho: $b_{1i} = b_{2i} = b_{3i} = 0,$ *for a* Log Likelihood Ratio Test	83***	168***	234***	332***	417***

* significant at 10%; ** significant at 5%; *** significant at 1%, Robust standard errors used

Table A12: Log Difference of SO2 and Fiscal Spending
Sites 75 KM Away From State Border for North East & Southern Regions Removed

	OLS	Fixed Site Effects (FSE)	Random Site Effects (RSE)
Share of PME over Total Spending –via State and Local Governments	-0.424**	-0.642**	-0.486*
	[0.187]	[0.311]	[0.272]
Share of PME over Total Spending – Federal Grants, Expenditure, Loans and Insurance	0.047	0.003	0.011
	[0.054]	[0.120]	[0.096]
Total State Government Spending over GDP	-0.444*	-0.525	-0.627
	[0.228]	[0.492]	[0.406]
Total Federal Government Spending over GDP	-0.035	-0.248*	-0.082
	[0.052]	[0.132]	[0.093]
Personal Income per Capita by County – log difference of 3 year moving average (in thousands)	-0.329*	-0.358	-0.356*
	[0.195]	[0.228]	[0.206]
Non-attainment Status for the whole county for the Previous Year (SO2 NAAQs)	-0.036	-0.01	-0.034
	[0.026]	[0.017]	[0.033]
Latitude of site	0.002		0.001
	[0.001]		[0.003]
Longitude of site	0.001		0.001
	[0.000]		[0.001]
Site characteristics and land use dummies	Yes	No	Yes
Year Effects	Yes	Yes	Yes
Adjusted R^2	0.02	0.02	0.02
Number of Observations	9853	9853	9853
Number of sites	1109	1109	1109

* significant at 10%; ** significant at 5%; *** significant at 1%, Robust standard errors used, Site characteristics include Rural, Suburban, Urban and City Center. Land Use dummies include Agricultural. Commercial, Desert, Forest, Industrial, Military Reservation. Mobile, and Residential

Table A13: Log Difference of SO2 and Fiscal Spending - Driscoll-Kraay standard errors

	Fixed Site Effects (FSE)	Fixed Site Effects (FSE)
Share of PME over Total Spending –via State and Local Governments	-0.474*** [0.169]	-0.474*** [0.100]
Share of PME over Total Spending – Federal Grants, Expenditure, Loans and Insurance	-0.018 [0.135]	-0.018 [0.092]
Total State Government Spending over GDP	-0.39 [0.496]	-0.39 [0.379]
Total Federal Government Spending over GDP	-0.185** [0.082]	-0.185*** [0.061]
Personal Income per Capita by County – log difference of 3 year moving average (in thousands)	-0.455*** [0.170]	-0.455*** [0.123]
Non-attainment Status for the whole county for the Previous Year (SO2 NAAQs)	-0.006 [0.039]	-0.006 [0.032]
Non-attainment Status for part of county for the Previous Year (SO2 NAAQs)	-0.023 [0.017]	-0.023*** [0.009]
Lags	1	6
Site characteristics and land use dummies	No	No
Number of Observations	15263	15263
Number of sites	1674	1674

* significant at 10%; ** significant at 5%; *** significant at 1%, Driscoll-Kraay standard errors standard errors used, Site characteristics include Rural, Suburban, Urban and City Center. Land Use dummies include Agricultural. Commercial, Desert, Forest, Industrial, Military Reservation. Mobile, and Residential

Table A14: Log Difference of SO2 and Fiscal Spending
Spatial Lag and Error Model (State Level)

	Spatial Lag Model	Spatial Error Model
Share of PME over Total Spending –via State and Local Governments	-0.489**	-0.483**
	[0.193]	[0.195]
Share of PME over Total Spending – Federal Grants, Expenditure, Loans and Insurance	-0.063	-0.062
	[0.077]	[0.077]
Total State Government Spending over GDP	-0.513**	-0.513**
	[0.250]	[0.244]
Total Federal Government Spending over GDP	0.051	0.051
	[0.056]	[0.058]
Personal Income per Capita by County – log difference of 3 year moving average (in thousands)	-0.679***	-0.679***
	[0.170]	[0.170]
Non-attainment Status for the whole county for the Previous Year (SO2 NAAQs)	-0.012	-0.012
	[0.083]	[0.083]
Non-attainment Status for part of county for the Previous Year (SO2 NAAQs)	-0.008	-0.007
	[0.036]	[0.036]
Spatial Lag	-0.039	
	[0.090]	
Spatial Autocorrelation		-0.003
		[0.093]
Number of Observations	1142	1142

* significant at 10%; ** significant at 5%; *** significant at 1%, Driscoll-Kraay standard errors standard errors used, Site characteristics include Rural, Suburban, Urban and City Center. Land Use dummies include Agricultural. Commercial, Desert, Forest, Industrial, Military Reservation. Mobile, and Residential

Table A15: Test For Structural Change Across Regions

	Test for Share of PME at the State and Local Lever*	
P-values	FE	RE
West	0.4955	0.8782
Midwest	0.0315	0.0232

***Null hypothesis**: regions have equal parameters for state share of PME and intercept

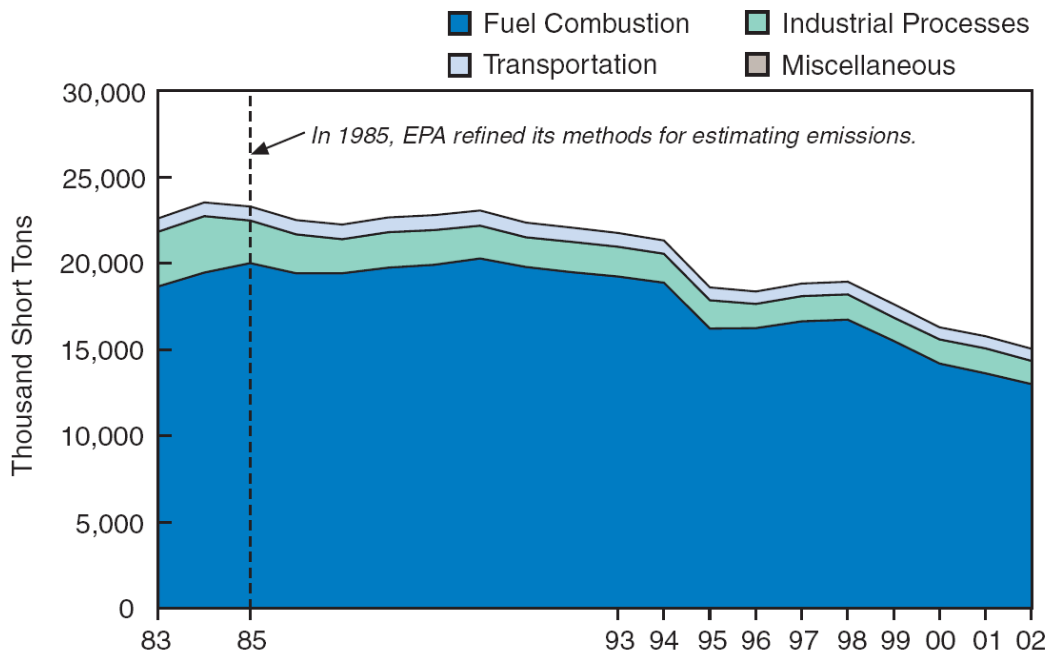
Table A16: Region Classification

Midwest	Northeast	South	West
Iowa	Wisconsin	Alabama	Alaska
Illinois	Connecticut	Arkansas	Arizona
Indiana	Massachusetts	District of Columbia	California
Kansas	Maine	Delaware	Colorado
Michigan	New Hampshire	Florida	Hawaii
Minnesota	New Jersey	Georgia	Idaho
Missouri	New York	Kentucky	Montana
North Dakota	Pennsylvania	Louisiana	New Mexico
Nebraska	Rhode Island	Maryland	Nevada
Ohio	Vermont	Mississippi	Oregon
South Dakota		North Carolina	Utah
		Oklahoma	Washington
		South Carolina	Wyoming
		Tennessee	
		Texas	
		Virginia	
		West Virginia	

Table A17: Estimates of Output Elasticities of energy in the Literature

Study	Elasticity	Country and years
US Industrial Sector Output Elasticities		
Kamerschen and Porter (2004)	Output Elasticity of Electricity for US Industries	1960-1992: 0.01 to 0.13
Stresing et al (2008)	Output Elasticity of Energy for US Industries	1960-1978: 0.663 (+/- 0.153) 1960-1993: 0.199(+/- 0.06)
Cebula and Herder (2010)	Output Elasticity of Electricity for US Industries	2002-2005: 1.57
Industrial Sector Output Elasticities of OECD Countries Including US		
Liu (2004)	GDP/Income elasticities for electricity in industrial sector in 23 OECD countries including US using GMM	1978-1999: 0.300 short run 1978-1999: 1.035 long run
Adeyemi and Hunt (2007)	Income Elasticity for industrial sector and energy for 15 OECD countries including US	1962-2003:0.55-0.78
Olund (2010)	9 OECD countries including US	1978-2006: 0.80
All Sectors Output Elasticities (Whole US Economy)		
Khanna (2001)	Output Elasticity of Energy for all of US	1965-1990: 0.30 to 0.35
Kamercshen et al (2005)	Total Income elasticity of electricity for all of US	1981-1998: 0.90
Kummel et al (2008)	Output Elasticity of Energy (Linex elasticities) for all of US	1960-1996: 0.35 (+/- 0.11)
Fillipini and Hunt (2011)	Income Elasticity of whole economy with regards to energy in 29 OECD countries	1978-2006: 0.4-0.8

Figure 1: SO2 emission Trends



Source: National Air Quality and Emissions Report, 2003 (EPA)

State Dominance

Figure 2: Fixed Site Effects – Share of PME State and Local Spending

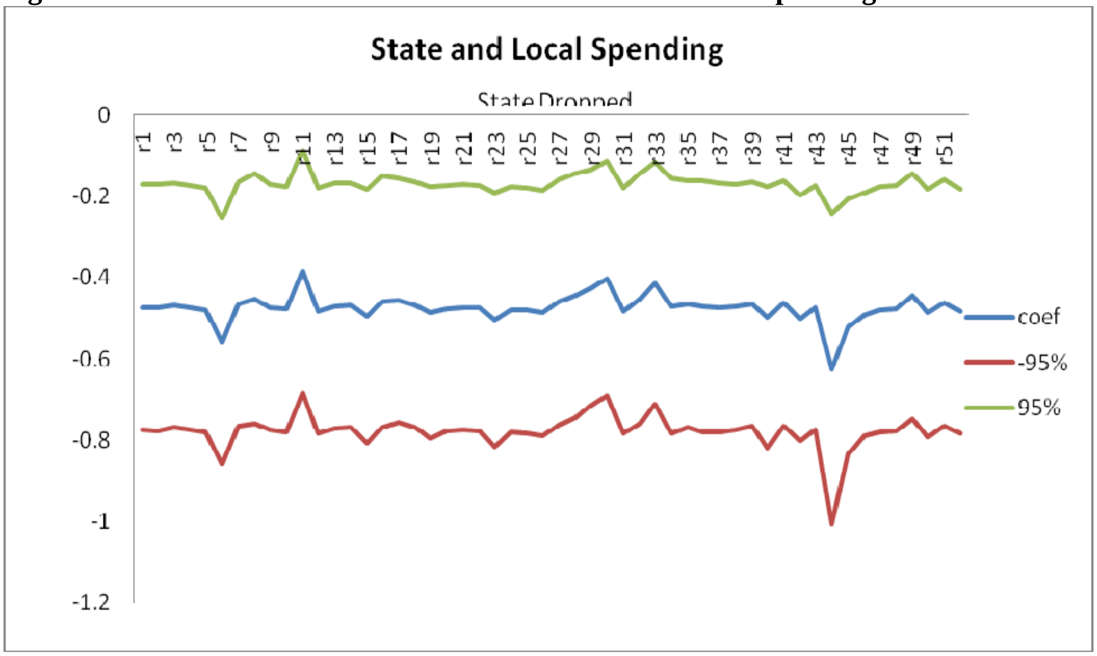


Figure 3: Random Site Effects – Share of PME State and Local Spending

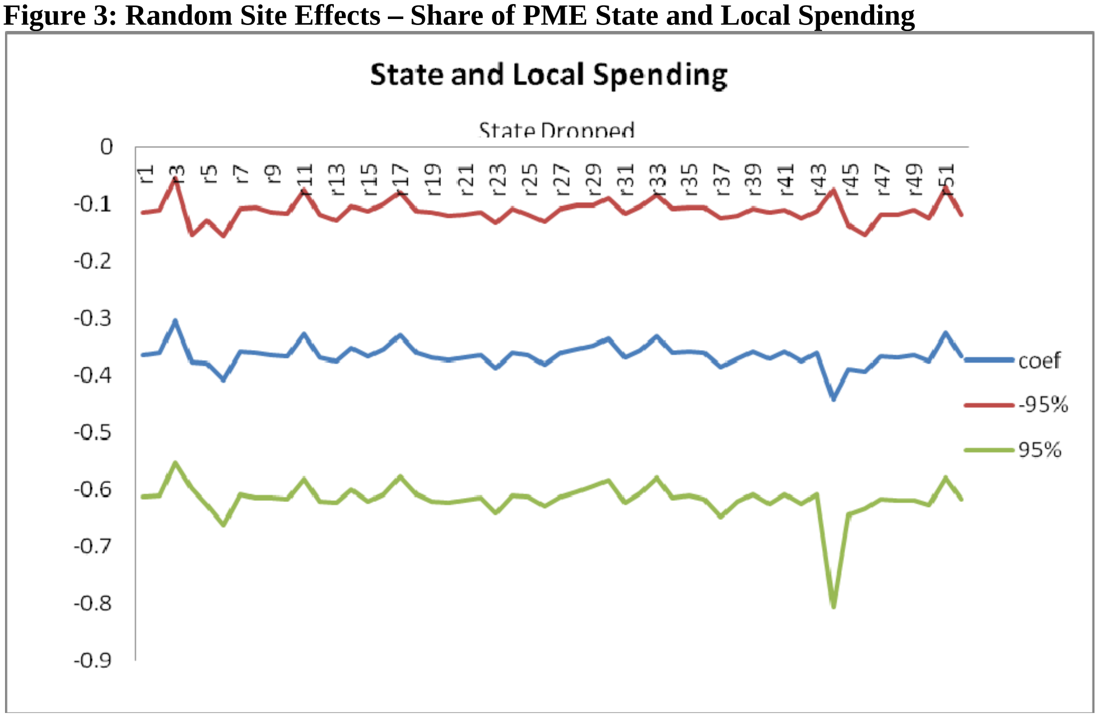
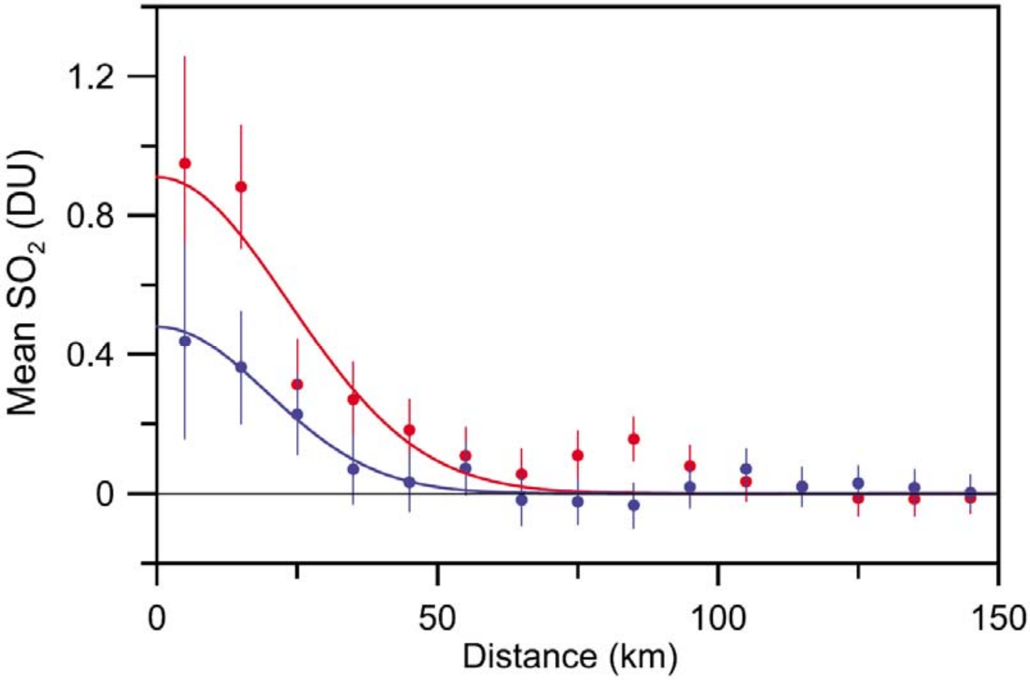


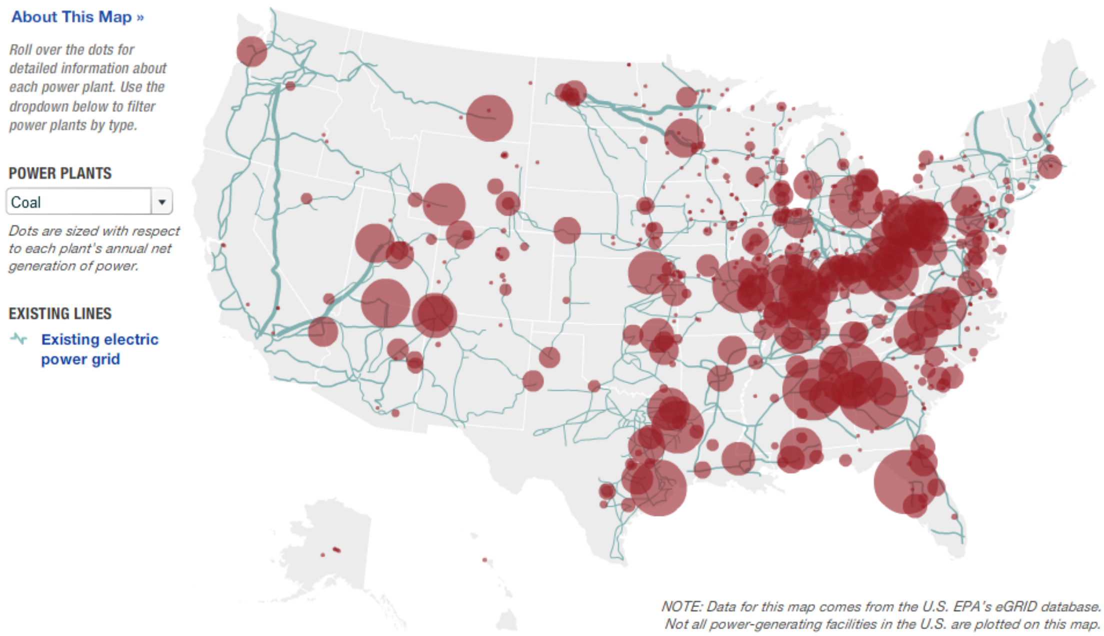
Figure 4: Distance Of SO2 Emissions From Source



Source: Fioletov et al. (2011)

Figure 4 shows the mean column SO2 values for the 2005–2007 period plotted as a function of a distance from the location of two large emissions sources: the largest US SO2 source (Bowen power plant in Georgia, estimated at 170 kT y−1) and the 20th□largest source (Belews Creek power plant in North Carolina, 88 kT y−1). Figure 11 demonstrates that SO2 values near the emissions sources became insignificant beyond about 50 km, even for the largest single source used in the study done by Fioletov et al. (2011).

Figure 5: Location of Coal Power Plants in the US



Source: EPA

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Chapter 2: US Government Spending Allocation Database by State (SADS)

By: Asif Islam

1. Introduction

The US government spending allocation database (from now on SADS) provides data on a set of government spending categories by state and local as well as federal governments distributed over states for the years 1983-2008.[9] The unique feature of this database is that it provides consistent disaggregated government spending data by functional categories across states while limiting the overlap of expenditures between the different government levels. This is achieved by categorizing and aggregating over 1,500 federal programs and combining it with data on state and local government spending.

In comparison to existing datasets, there are three specific contributions of the SADS database: (i) It provides aggregated federal spending data by functional categories distributed over states. Currently available spending datasets essentially include time series national aggregates as maintained by the Bureau of Economic Analysis, and the Office of Budget and Management. Furthermore these aggregated categories are typically based on spending by federal agency or department instead of functional categories. (ii) Aggregated federal spending categories are separated by direct expenditures including grants, salaries and wages, and federal indirect expenditures that

[9] The database will be updated and revised as the data sources are updated. A link to the dataset can be found here: http://terpconnect.umd.edu/~aislam1/

include loans and insurance. (iii) SADS combines a pre-existing state government spending database with the federal spending data, developing aggregated categories consistent across federal and state government spending and mitigates double counting of government expenditures. There is currently no database that has consistent spending categories by function across state and federal governments distributed geographically over all states.

There are signification contributions the SADS database can have towards future research. For instance the 2008-2009 US financial crisis has indicated that although federal governments have risen spending by enacting various stimulus packages, most of the impact has been diminished due to corresponding spending cuts by state and local governments. Furthermore, there is much debate on the pros and cons of undertaking fiscal policy at the state versus federal level of government.

The key challenges of separately considering federal and state and local government spending involve (a) creating spending categories that are consistent, and (b) tackling the issue of double counting since part of state and local spending is from the federal government. In relation to (a), the more detailed the spending categories, the greater the potential for research. However, due to constraints with regards data sources, only a certain level of disaggregation is possible in order to maintain consistency. The main spending categories include Education, Health, Social Welfare, Housing, Public Order and Safety, Parks Libraries Arts and Humanities, Infrastructure and Communication, Economic Affairs and Private Subsidies, and Other Spending. State government spending includes environmental spending as part of health expenditures. Thus, in the SADs database, environmental spending is available as a separate category at the federal level. In relation to (b), the issue of double counting is alleviated by using a third data source in order to identify and exclude federal transfers to state governments. There are several key assumptions and procedures used to maintain a degree of consistency, and these are explained in detail in this document.

This paper is organized as follows: section 2 provides a description of data sources and methodology of data collection, section 3 highlights the issues and procedures used to address them, section 4 provides spending definitions and coverage, section 5 presents the data and examples of how it may be used, and finally section 6 concludes.

2. Sources and Methodology

The SADS database is created by combining three different data sources: The Consolidated Federal Funds Report (CFFR), State and Local Government Finances, and the Federal Aid to States (FAS), which is part of the CFFR series. All data sources are maintained by the US Census Bureau. A rigorous understanding of the three data sources is essential to determine the quality of SADS database. Each data source is constrained by differing levels of spending aggregation, and degree of accuracy due to changes in the data source over time. The spending aggregation limits the level of spending detail the SADS database can attain, and the changes in the underlying data sources over time have to be accounted for in order to have a consistent database. This section will describe the data sources, highlighting the strengths and weaknesses of each, and where possible pointing out the impact on the final quality of the data. Each data source will be analyzed with regards to richness (detail), inter-temporal consistency, spending exclusions, data limitations, and other issues.

The Consolidated Federal Funds Report (CFFR)

The Consolidated Federal Funds Report (CFFR) maintained by the US census bureau is the primary source for federal expenditures. The data consists of federal expenditures or obligations distributed by state and local areas at the program level. The report is created by combining several statistics on federal government expenditures. The primary sources are: Federal Assistance Award Data System (FAADS), Federal Procurement Data System, U.S. Department of Defense, Office of Personnel Management, U.S. Postal Service, and Federal Aids to State Survey.

Most of the information is submitted by individual agencies to the federal reporting system. CFFR is available from 1983 – 2008, with more recent years made available as the reports are completed. The data is rich in detail as all spending is presented as individual programs identified by the Catalog of Federal Domestic Assistance (CFDA) number and geographical location and is available for over 1500 programs. The CFFR data set does have a few alterations over time that mostly occurs in 1993. Data before 1993 has the following differences from the data 1993 onwards: (i) there is no department classification or agency classification in the database. Most of the agencies and departments are inferred by the program ID or CFDA numbers present in the database. (ii) Most salary, wage, and procurement data have generic program IDs, and thus cannot be identified by agency and department for Pre-1993 data, apart from Defense, Postal Service, and the FBI, which have special codes. Data 1993 onwards does not have this issue as agency coding is available for salary, wages and procurement data. (iii) Certain agencies and branches are missing data pre-1993. These include Corps of Engineers – Civil Works, Executive Office of the President, and the Judicial Branch. Further contact with Census Bureau indicated that it is not possible to recollect the missing information for pre-1993 data. Corps of Engineers – Civil Works is also missing for 2008.

There are limitations in the coverage of CFFR data. Amounts excluded from the CFFR are grouped into two general categories - conceptual exclusions and agency/program omissions. Conceptual exclusions include spending not geographically distributed for example all international transactions and foreign payments, and also agencies not covered by the reporting systems. The reporting systems and federal agencies omit federal procurement, travel, and other expenditures to the extent that they are not covered by contractual agreements or government charge card purchases. Exclusions include: Net interest on federal government debt, Central Intelligence Agency, Defense Intelligence Agency, National Security, Agency, Procurement actions of the judicial and legislative sectors of the federal government, Expenditures other than salaries and wages are not available for the Federal Deposit Insurance Corporation, National Credit Union Administration, and Federal Savings and Loan Insurance Corporation.

An additional limitation of the CFFR is that it is not possible to identify whether the recipient of the expenditure is a state or local government or a private entity. This necessitates a third data source to account for federal expenditures to state governments. Finally assistance spending may also involve obligations. Typically de-obligations are indicated as negative amounts in CFFR. It is difficult to track, by program, when obligations were made, and how to distribute the negative amounts in prior years. Thus, negative figures are retained, and appear as a subtraction from the aggregate estimation of the spending type. In summary, the CFFR data is rich in detail with the presentation of all spending at the program level allowing for flexibility in the creation of spending categories.

State and Local Government Data Source

The State and Local Government Finances maintained by the US Census Bureau is the data source for state and local government spending. Local governments specifically comprise of counties, municipalities, townships, special districts, and independent school districts. Activities of dependent public school systems are included with the data of their parent state or local government. This data is collected by the census bureau in 2 ways. First, the US Census Bureau conducts the nation's Economic Census every five years, in years ending in "2" and "7", where the census of governments is one component of the economic census. The US Census Bureau also conducts recurrent annual surveys related to the census of governments. Essentially four methods are used to collect the data: Mail Canvass, Compilation using direct government reports and records, central collection where other states share data from their own collection systems, and finally imputation for government units that did not respond. Imputation is typically used by examining existing public records.

The coverage is from 1977 to 2009, and the data is fairly consistent. One general issue is that local government spending is omitted for 2001 and 2003. Data users can either choose to interpolate these years, or use the totals for state government spending alone. The main limitation of this data source is the level of aggregation presented. This limitation essentially dictates the possible attainable spending categories for the SADS database in order to allow for spending comparisons across the different levels of government. For instance research and regulation spending is typically included in spending aggregates, and it is impossible to separate out conservation efforts (forest conservation) and marketing efforts (timber production promotion) from spending under economic affairs. There is also certain unexpected bundling of expenditures, for instance environmental spending is under health spending.

In summary, State and Local Government Finances is the most consistent database with regards to computation and collection across US states. Its main drawback is it level of disaggregation in spending categories.

Federal Aid to States (FAS)

Federal Aid to States (FAS) is the data source for federal spending directly to state governments. FAS is part of the CFFR series, and thus has the advantage that it is consistent with the main source of federal spending data for the SADS.

Similar to the CFFR, the FAS data have been consolidated and tabulated by the Census Bureau under the auspices of the US Office of Management and Budget (OMB). The data in the FAS is similar to the CFFR apart from the fact that the former consists of federal grants to local and state governments and is available at the program level of disaggregation, while the latter has data on all grants both to government and non-government entities with more aggregated data. Thus subtracting FAS data from CFFR would provide federal expenditures excluding spending on state and local governments.

The FAS data includes the following: Direct cash grants to state or local government units, payments for grants-in-kind, such as purchases of commodities distributed to state or local government institutions (e.g., school lunch and breakfast programs), payments to nongovernment entities when such payments result in cash or in-kind services passed on to state or local governments, payments to regional commissions and organizations that are redistributed to the state or local level, federal government payments to state and local governments for research and development that is an integral part of the provision of public services, and federal revenues shared with state and local governments. Specific exclusions from the FAS that are available in the CFFR are: federal government payments directly to individuals, profit or nonprofit institutions not covered above, and payments for services rendered. The FAS report was known as the Federal Expenditures by State prior to 1997. The available coverage is for the years 1981-2008.

The main drawback of the FAS database is that spending is not presented at the program level and thus the level of disaggregation is much greater than CFFR. This adds a further constraint on the possible degrees of spending disaggregation for the

SADS database. However, the aggregation categories can generally be matched to state level spending categories, and thus the limitation does not detract from the possible categories at the state and local level. Furthermore, there are several inconsistencies in the totals of the categories and subcategories for data before 1990s. The specific issue is that the category totals do not match with the totals of the subcategories. There are also inconsistencies between total state spending listed, and the total spending of all state sub-categories. The state sub-categories do not add up to the total state total for data after the 1990s. Further communication with the US Census Bureau revealed that they are unable to provide documentation or account for the inconsistencies. For the SADS database, the total of the sub-categories of spending in the FAS are used as they are essentially what is required for creating the categories. Thus it is assumed that the error is in either calculation of the totals in the FAS dataset, or there are missing categories.

In summary, the FAS data is the most problematic of all 3 data sources due to its level of disaggregation and inconsistencies in totals. However, it is the consistent with the CFFR data, and as far as the author knows, the best available data for expenditures by federal government to state governments.

3. Procedures For Resolving Issues

There are essentially two issues that have to be accounted for in the creation of the SADS database. The first is the treatment of administrative spending in the CFFR data source. Second is the removal of direct spending by federal governments to state governments in order to avoid double counting.

Treatment of Administrative Expenditures

Administrative expenditures are allocated by department for the CFFR data 1993 onwards. If all the programs in a department can be identified under one category of spending, the administrative expenditures are then included in that spending category. However, when a whole department does not fall under one category of spending, the administrative expenditures are distributed into different spending categories in the department by the ratio of each type of spending over total department spending.

$$adst_{ij} = \frac{tot_{ij}}{tot_j} * adst_j \qquad (1)$$

Where $adst_{ij}$ is administrative spending for category i in department j. tot_{ij} is the total spending for category j in department i, while tot_j is the total spending in department j excluding un-allocable administrative expenditures. Therefore $\sum^{i} tot_{ij} = tot_j$. Finally $adst_j$ is the un-allocable administrative spending for department j. The assumption is that administrative spending is proportional to the amount of spending per category in each department.

In the case of pre-1993 data, the administrative spending is not allocated by department. Thus the administrative spending is first allocated to each department by the proportion of department spending over total spending. This is then further distributed into the type of spending within the department, using the proportion of the category of spending in the department over total department spending. Thus administrative spending is spread over departments using the following formula:

$$adst_j = \frac{tot_j}{tot} * adst \qquad (2)$$

Where $adst_j$ is the administrative spending for department *j*, tot_j is the total spending in department *j*, tot is the total spending in CFFR excluding un-allocable administrative spending such that $\sum^{j} tot_j = tot$ and $adst$ is the un-allocable total administrative for the whole of CFFR. The assumption is that administrative spending is proportional to the amount of spending per department.

Excluding Federal Grants to States

The most significant obstacle in disaggregating federal, state and local spending is the possibility of double counting. For example, in the CFFR, federal spending on states is counted as federal expenditures. However, databases on state government spending would count such expenditures as state government spending. Thus such items would be double counted. In order to remove double counting, the Federal Aid to States (FAS) is used, which is part of the CFFR series.

Each spending category is identified in the FAS dataset that corresponds to the categories created in the CFFR data. Thus the final categories for direct federal spending are created by a simple subtraction as indicated in equation (3) below:

(3) $$fedsp_{SADS} = fedsp_{CFFR} - fedsp_{FAS}$$

Where *fedsp* is the spending category, and the subscript indicates the database. Therefore we subtract out transfers from the federal government to the state governments from federal spending. The accuracy of federal spending in the SADS database is dependent on the degree of consistency of the categories between CFFR and FAS. Under the assumption that the FAS data comprehensively covers all federal spending to states, the SADS data can be considered reasonably consistent.

4. Description of SADS Categories

There are essentially 9 categories of spending in the SADS database: (i) Education, (ii) Health, (iii) Social Security & Welfare, (iv) Housing, (v) Public Order and Safety, (vi) Parks, Libraries, Arts, and Humanities, (vii) Infrastructure and Communication, (viii) Economic Affairs & Private Subsidies, and (ix) Other Spending. Spending by state and local governments exactly match each of the above aggregate categories, apart from

Economic affairs & private spending and other spending. However, federal spending has to be aggregated over individual programs in order to generate similar categories.

For federal spending, each program is identified by department, and categorized under the above categories. This identification is done using the program description provided in the data, or obtained by tracking the CFDA number for each program through other sources. Each type of spending can be broken down into two groups – direct spending and assistance spending. Direct spending includes grants, salaries and wages, procurement contracts, and other direct payments. Direct assistance includes direct loans, guaranteed/insured loans and insurance. The components of direct spending and assistance spending are presented in table 1.

A few departments have more than one type of government spending. Each program is classified by spending type by department. For instance, in the department of Agriculture, about 37% of department spending on average for all states was on private subsidies in 2008. The top private subsidy is crop insurance, which typically accounts for most of the Agricultural spending on private subsidies in addition to production stabilization and flexibility payments. However, Agricultural spending on Food stamps and school lunch programs account for about 21% of Agricultural department spending, both of which fall under the category of social welfare.

All spending in the database is presented as shares of total government spending. Below is a short description of the spending categories available in the SADS database

1) Education

There are three variables available under education: the share of education spending by state and local governments over total state and local government spending, the share of direct education spending by federal governments over total direct federal spending, and finally the share of federal education loans and insurance spending over federal total loans and insurance spending. State and local education spending is categorized according to the Government State and Local Finances database as spending under education. This spending category includes essentially all spending involved in the operation, maintenance, and construction of public schools and education institutions for all levels of education. The corresponding federal categories include education spending by the department of education, and typically most expenditure carried out by departments that involve education or labor training programs.

2) Health

There are two variables available under health: the share of health spending by state and local governments over total spending by state and local governments, and the share of direct health spending by federal governments over total direct spending by federal governments. State and local health spending is categorized according to the Government State and Local Finances database as spending under health. This spending category includes essentially all spending towards the provision of services for the conservation and improvement of public health and financial support of other governments' health programs. However, environmental programs are also included under state and local health spending. The corresponding federal category includes spending by the department of health. Federal environmental spending by the EPA is not included in this category, but is available as a spate category in case users would like to include it.

3) Social Welfare

There are two variables available under social welfare: the share of social welfare and social security spending by state and local governments over total state and local government spending, and the share of direct social welfare and social security spending by federal governments over total direct federal spending. State and local social welfare and security spending encompasses public welfare spending, employment security administration, employee retirement spending, unemployment and workers compensation spending. The corresponding federal categories include spending over a wide range of federal departments. Social security administration, Earned income tax credit from the treasury department, food stamps from the department of agriculture, retirement and disability payments, as well as weatherization assistance to low income households, and Unemployment trust funds.

4) Housing

There are three variables available under housing: the share of housing spending by state and local governments over total state and local government spending, the share of direct housing spending by federal governments over total direct federal spending, and finally the share of federal housing loans and insurance spending over total federal loans and insurance spending. State and local housing spending encompasses construction, operation, and support of housing and redevelopment projects and other activities to promote or aid public and private housing and community development. The corresponding federal categories mostly include housing spending by the department of housing and urban development. A few programs by other departments are also included, for example spending on rural housing by the department of Agriculture.

5) Public Order and Safety

There are three variables available under public order and safety: the share of public order and safety spending by state and local governments over total state and local government spending, the share of direct public order and safety spending by federal governments over total direct federal spending, and finally the share of federal public order and safety loans and insurance spending over total federal loans and insurance spending. State and local public order and safety spending encompasses judicial and legal, legislative activities, police protection, corrections institutions, protective inspection and regulation, and fire protection spending. The corresponding federal categories include spending by the department of justice, homeland security programs, and spending by the legislative and judicial branches.

6) Parks, Libraries, Arts and Humanities

There are two variables available under parks, libraries, arts and humanities: the share of parks, libraries spending by state and local governments over total state and local government spending, and the share of direct federal spending on parks, libraries, arts and humanities over total direct federal spending. State and local spending involves spending on public libraries, and parks and recreation. The corresponding federal categories essentially include spending by the Institute of Museum and Library Sciences, National Park Service, National Foundation on the Arts and Humanities, Tennessee Valley Authority, Appalachian Region Commission.

7) Infrastructure and Communication

There are three variables available under infrastructure and communication: the share of infrastructure and communication spending by state and local governments over total state and local government spending, the share of direct federal infrastructure and communication spending over total direct federal spending, and finally the share of federal infrastructure and communication loans and insurance spending over total federal loans and insurance spending. State and local infrastructure and communication spending includes general public buildings, highways, sanitation, sea and inland port facilities, and transit utilities. The corresponding federal spending encompasses a wide range of departments that engage in infrastructure spending. However the main categories include spending by the department of transportation, development grants for public works by the department of commerce, water resources development, and flood insurance.

8) Economic Affairs and Private Subsidies

There are three variables available under economic affairs and private subsidies: the share of economic affairs and private subsidies by state and local governments over total by state and local government spending, the share of direct economic affairs and private subsidies spending by federal governments over total direct federal spending, and finally the share of federal economic affairs and private subsidy loans and insurance spending over total federal loans and insurance spending. State and local economic affairs and private subsidy spending involve spending in economic affairs (agriculture, fishing, forestry, and mining), miscellaneous commercial activities, utility spending (water, gas, and electric) and liquor store spending. Economic affairs tends to cover most of private subsidies, however it is difficult to disaggregate conservation and regulation efforts for state and local spending, and thus this category includes not just private subsidies but other types of spending that falls under economic affairs. Federal spending categories are made consistent with this definition. They essentially involve spending by the department of agriculture excluding food stamps ad extension services, the department of interior, and small business administration. A few programs in each of these departments are under separate categories due to the nature of the programs.

9) Other Spending

The three variables include other spending by state and local governments, federal direct spending, and federal loans and assistance spending. At the state level, the bulk of this spending is those that are hard to categorize. This includes spending on parking facilities, veterans bonuses, general un-allocable spending, and administration spending that cannot be categorized under the above categories. Federal spending mostly includes defense spending, veterans' affairs, general services administration and various international programs. This category is the most disparate when comparing the state and federal levels.

10) Separate Federal Categories

There are two separate federal categories available to data users. These include spending by the Environmental Protection Agency (EPA) and federal research programs that are difficult to categorize under the above programs, for instance the National Science Foundation (NSF), and National Aeronautics and Space Administration (NASA). It may make sense to include NSF spending under education spending, however it is worth noting that research under NSF is broad, and encompasses several categories in the SADS database. This is complicated by the fact that research spending under is already included each individual category at the state level. Thus, it is up to the user to decide how they wish to allocation NSF, NASA, and EPA spending. EPA spending is a separate category mostly due to the design of the state spending categories.

Environmental spending by states is included under health spending, and it is not possible to separate the two. Users may be uncomfortable combining health spending and EPA spending at the federal level, and thus the option is left to their discretion.

5. The Use of SADS Data

This section essentially consists of three parts. First excerpts are provided from the data to give the reader a feel for what is available in the SADS database. Second, an example is provided of how the SADS database can be used to observe the evolution of spending over time across states. Finally, a simple study is conducted to explore the possibility of substitution or complementarities for the same spending categories but across different levels of government. Finally, some caveats are provided with regards to how to interpret the data.

Excerpt from SADS

Tables 2 through 4 provide trends of all categories of spending, averaged over all states, for state and local governments, federal direct spending, and federal loans and insurance. Federal direct spending includes grants, salaries and wages, and procurement contracts. From this data much can be inferred about the inter-temporal movements of spending for each of the categories indicated as well as level of government.

Tables 5 through 7 provide cross-state comparisons of spending averaged over 1983-2008. This data is provided for all the SADS categories as well as for state and local governments, federal direct spending, and federal assistance spending (federal loans and insurance). In additional to the shares of spending provided, total expenditures for each state over time will also be provided in case users would like to work with real values instead of shares.

Changes in Social Welfare, Health, and Education Spending

A simple illustration of what can be done using the SADS database is shown in tables 8, 9 and 10. Welfare, health and education spending shares are tracked over decade averages of 1983-1989, 1990-1999, and 2000-2008. Social welfare and health spending involve state and local spending, and federal direct spending, while education spending additionally includes federal loans and insurance.

Perhaps not surprising, the one striking feature is that the differences across the spending shares of states is far greater than the differences over time for each state. Health and social welfare spending shares have gone up for most states from the 80s to the 90s, however the trends have been mixed moving into the 2000s, as some states have experienced increases in the spending shares while others have declined. The federal direct spending on education consists of mostly grants and administrative costs. The better indication of education spending is the assistance spending in terms of loans.

Most of the assistance spending provided in table 10 involves student loans, and the changes across the years for states vary significantly. Contrast the District of Columbia where overall the loans have been on an upward trend to Minnesota, which has experienced sharp declines. In contrast, state and local spending on education over time has been mostly flat for both Minnesota and the District of Columbia. The SADS data provides finer annual data as opposed to the decadal averages presented and thus these trends can be studied in further detail.

Complementarities and Substitution of spending shares across levels of government

Table 10 and 11 present the correlations of education, health, and social welfare and security spending shares across government levels, and specifically for education, across federal direct and assistance spending as well. These are pair-wise correlation, all of them significant at 1%. A few interesting results stand out. For instance state spending on education is negatively correlated with both federal direct and assistance spending, both with a correlation around -0.10. This may indicate some degree of substitutability between state and federal spending in terms of education. In contrast federal spending shares in education for direct and assistance spending is positively correlated at 0.30. Since federal direct education spending mostly captures administrative spending, it makes sense that there would be a high positive correlation between direct and assistance federal spending on education.

We also find a negative correlation between federal and state level spending share on health of around -0.072, implying a degree of substitution between federal spending and state and local spending in health. However, with regards to social security and welfare spending, we find a positive correlation of 0.19 indicating some degree of complementarities between state and federal social security and welfare spending.

Caveats about the use of SADS

Thus far, the potential inconsistencies across spending categories and the limitation of accuracy due to different category aggregation across data sources have been mentioned as potential drawbacks. One additional drawback is the interpretation of spending. Recall that federal spending is direct federal spending to individuals in states (as opposed to state governments), while for state level spending, this may include federal spending as long as the delivery through state governments. Thus conceptually, the distinction between federal and state level government spending is really by delivery. Any analyses on the effectiveness of federal spending in the SADS database will be unable to make statements about the overall efficacy of federal spending, since federal spending visa states may still be efficient. The analyses can mainly make statements on direct federal spending.

6. Conclusion

This document has presented a unique dataset on US government spending allocation for a set of government spending categories by state and local as well as federal governments distributed over states for the years 1983-2008. The unique feature of this database is that it provides disaggregated government spending categories by federal and state and local governments levels distributed over states and also limits the overlap of expenditures between the different government levels. The drawbacks have been specified, and also the procedures to handle different issues have been described. A few illustrations were provided on how this data may be used by researchers. Finally, this database will be updated regularly as the data sources are updated. Furthermore, the codebooks for the aggregation of each type of federal spending program into respective spending categories will be made available online for users to create new sub-categories or submit possible errors that will be corrected with each round of updates. With continued feedback from users, the SADS database may expand and also improve in quality

Tables And Figures

Table 1: Direct Spending and Assistance

Direct Spending	Assistance
Grants (Block, Formula, Project, and Cooperative Agreements) Salaries and Wages Procurement Contracts Retirement and Disability Payments for Individuals Other Direct Payments for Individuals Direct Payments Other than for Individuals	Direct Loans Guaranteed/Insured Loans Insurance

Table 2: Annual Shares of State & Local Government Spending Categories over Total State and Local Government Spending averaged over all States

year	Education	Health	Social Welfare	Housing	Public Order and Safety	Parks, Libraries, Arts and Humanities	Infrastructure and Communication	Economic Affairs and Private Subsidies	Other Spending (Mostly includes Military/ Defense Spending)
1983	30.07	7.39	17.29	1.41	7.71	1.74	13.37	13.64	7.38
1984	30.40	7.46	15.99	1.45	7.83	1.69	13.73	13.49	7.97
1985	30.20	7.22	15.96	1.46	7.87	1.69	13.91	13.54	8.14
1986	30.52	7.10	15.69	1.48	7.91	1.71	13.77	13.29	8.53
1987	30.37	7.07	15.94	1.46	7.97	1.71	13.58	13.21	8.68
1988	30.74	7.27	15.76	1.44	8.17	1.77	13.50	12.67	8.68
1989	30.76	7.32	15.92	1.51	8.28	1.81	13.37	12.49	8.53
1990	30.87	7.39	16.65	1.45	8.37	1.82	12.99	12.15	8.32
1991	30.50	7.31	18.10	1.42	8.30	1.83	12.89	11.67	7.99
1992	29.40	7.29	20.20	1.39	8.17	1.82	12.50	11.39	7.85
1993	29.58	7.43	21.16	1.39	8.02	1.72	12.37	10.91	7.42
1994	29.58	7.56	21.09	1.42	8.14	1.76	12.33	10.94	7.19
1995	29.54	7.47	21.53	1.42	8.24	1.77	12.25	10.75	7.03
1996	30.00	7.48	21.17	1.40	8.46	1.80	12.08	10.56	7.05
1997	29.85	7.28	20.86	1.41	8.64	1.89	12.21	10.87	7.01
1998	30.29	7.21	20.16	1.44	8.75	1.93	12.26	10.89	7.07
1999	30.52	7.07	20.11	1.36	8.85	1.92	12.22	10.91	7.04
2000	30.47	7.05	20.21	1.39	8.90	1.90	12.24	11.03	6.81
2002	29.72	6.89	21.98	1.39	8.59	1.91	11.93	11.13	6.46
2004	29.72	6.81	23.46	1.52	8.37	1.79	11.46	10.62	6.25
2005	29.88	6.99	23.29	1.60	8.54	1.80	11.41	10.35	6.14
2006	30.00	7.04	22.68	1.55	8.55	1.86	11.49	10.73	6.11
2007	29.96	7.04	22.15	1.63	8.56	1.86	11.64	11.02	6.16
2008	30.07	7.18	22.24	1.66	8.55	1.92	11.48	10.75	6.16

Table 3: Annual Shares of Federal Direct Government Spending Categories over Total Federal Direct Government Spending averaged over all States. Direct spending includes grants, salaries and wages, and procurement contracts

year	Education	Health	Social Welfare	Housing	Public Order and Safety	Parks, Libraries, Arts and Humanities	Infrastructure and Communication	Economic Affairs and Private Subsidies	Other Spending (Mostly includes Military/ Defense Spending)	EPA	Federal Research excluded from other Categories (NSF, NASA)
1983	1.49	11.56	44.74	1.42	0.14	0.00	0.00	2.83	33.75	0.13	3.93
1984	1.75	11.26	44.00	1.51	0.13	0.01	1.08	1.92	37.89	0.18	0.26
1985	1.54	11.90	42.66	1.09	0.07	0.01	0.00	3.53	35.53	0.04	3.63
1986	1.70	12.23	42.36	1.86	0.23	0.03	0.88	3.83	36.47	0.04	0.37
1987	1.90	12.62	41.45	2.36	0.16	0.03	0.76	4.42	35.89	0.06	0.35
1988	2.09	12.94	42.70	1.82	0.12	0.03	0.69	4.71	34.41	0.13	0.35
1989	2.38	13.28	44.16	1.98	0.16	0.04	0.51	4.08	33.01	0.05	0.35
1990	2.31	15.00	45.38	1.79	0.36	0.03	0.51	2.82	31.24	0.16	0.41
1991	2.29	14.63	46.19	1.83	0.16	0.03	0.90	2.78	30.51	0.28	0.41
1992	2.10	16.87	47.04	1.69	0.21	0.03	0.83	2.59	28.11	0.11	0.43
1993	1.62	15.48	43.63	1.34	0.85	0.14	1.11	5.41	28.90	0.25	1.26
1994	1.46	15.69	44.31	0.95	0.95	0.14	1.42	5.11	28.64	0.20	1.15
1995	1.44	16.11	45.42	0.80	1.07	0.11	1.10	4.69	28.02	0.24	1.01
1996	1.21	16.82	45.41	0.86	1.11	0.10	0.99	4.07	28.13	0.30	1.02
1997	0.96	18.71	45.50	1.02	1.00	0.09	1.20	4.04	26.19	0.27	1.00
1998	1.24	17.66	45.65	0.58	1.20	0.10	1.22	4.61	26.35	0.32	1.07
1999	1.02	17.48	45.30	0.40	1.11	0.12	1.47	5.53	26.22	0.32	1.04
2000	0.89	17.32	44.89	0.97	1.09	0.13	1.53	5.67	26.31	0.20	0.99
2001	1.64	17.19	45.03	0.57	1.02	0.13	1.48	6.74	24.60	0.19	0.92
2002	1.45	18.22	43.84	0.15	1.10	0.14	1.82	6.46	25.70	0.18	0.94
2003	1.96	17.73	43.60	0.22	1.82	0.16	1.94	4.94	26.55	0.14	0.93
2004	2.03	18.21	42.51	0.20	1.62	0.15	1.27	4.92	28.03	0.13	0.94
2005	1.66	18.84	41.44	0.74	2.10	0.15	0.92	5.14	27.91	0.20	0.91
2006	2.14	19.08	40.80	0.68	2.57	0.17	1.50	4.77	27.33	0.14	0.84
2007	2.06	18.78	40.90	0.23	1.81	0.16	2.00	4.14	28.92	0.12	0.89
2008	2.07	20.80	40.56	0.31	1.82	0.18	0.77	4.51	27.92	0.12	0.93

Table 4: Annual Shares of Federal Government Loans and Insurance Spending Categories over Total Federal Government Loans and Insurance averaged over all States

year	Education	Housing	Public Order and Safety	Infrastructure and Communication	Economic Affairs and Private Subsidies	Other Spending (Mostly includes Military/ Defense Spending)
1983	6.47	20.64	32.09	4.55	31.50	4.72
1984	9.71	25.99	30.86	2.85	25.66	4.89
1985	10.32	18.43	36.74	2.04	27.89	4.55
1986	6.31	27.86	37.04	1.75	22.15	4.85
1987	4.91	38.37	32.25	1.20	18.11	5.13
1988	6.96	28.70	38.57	1.42	20.63	3.70
1989	7.01	36.44	36.03	0.87	16.92	2.70
1990	7.50	32.64	36.51	1.38	18.83	3.12
1991	8.03	33.72	34.83	1.53	19.41	2.45
1992	7.22	26.92	43.30	1.32	19.46	1.76
1993	7.27	29.44	40.93	1.51	18.19	2.64
1994	7.63	32.60	36.32	1.25	16.55	5.63
1995	9.01	18.64	41.54	1.31	25.59	3.87
1996	9.00	22.15	42.23	1.04	21.57	3.98
1997	9.92	20.93	47.62	0.95	17.39	3.17
1998	10.38	23.36	45.48	1.00	16.24	3.54
1999	9.96	19.92	45.59	1.13	17.79	5.60
2000	9.90	20.86	47.96	1.38	17.62	2.28
2001	8.98	22.71	46.82	1.28	17.65	2.54
2002	9.48	25.42	44.37	1.62	16.41	2.70
2003	10.02	26.17	43.57	1.72	15.70	2.81
2004	12.27	19.65	44.17	1.45	16.19	6.26
2005	13.33	12.80	51.04	2.00	16.31	4.51
2006	11.70	11.58	54.49	0.97	16.81	4.44
2007	11.77	10.91	54.77	1.11	17.36	4.07
2008	8.43	22.04	47.34	0.84	15.60	5.75

Table 5: Shares of State & Local Government Spending Categories over Total State and Local Government Spending by Geographical Location (1983-2008 average)

State	Education	Health	Social Welfare	Housing	Public Order and Safety	Parks, Libraries, Arts and Humanities	Infrastructure and Communication	Economic Affairs and Private Subsidies	Other Spending (Mostly includes Military/ Defense Spending)
Alabama	31.34	13.73	17.98	1.23	6.71	1.35	9.71	12.16	5.74
Alaska	21.19	3.01	15.91	1.74	7.07	1.20	14.35	23.44	12.07
Arizona	29.88	4.65	17.15	0.92	10.79	2.20	11.98	14.83	7.07
Arkansas	35.28	8.00	21.87	1.02	7.12	1.23	11.14	8.12	6.08
California	25.69	7.51	22.43	2.00	11.01	1.80	9.20	12.96	7.11
Colorado	30.52	5.95	18.46	1.21	8.72	2.85	12.71	11.51	8.05
Connecticut	27.76	6.71	22.80	1.98	8.84	1.47	10.38	11.52	8.46
Delaware	33.31	5.11	16.32	1.85	9.16	1.54	14.06	8.01	10.64
District of Columbia	13.30	7.59	21.97	3.47	13.27	2.10	24.16	7.52	6.63
Florida	27.18	8.22	15.31	1.12	11.45	2.31	12.89	13.32	7.77
Georgia	31.38	11.35	17.94	1.38	8.21	1.47	11.26	11.86	5.08
Hawaii	23.83	7.01	19.55	2.70	8.23	2.86	14.34	13.11	8.28
Idaho	33.07	8.16	19.44	0.67	8.53	1.47	13.26	9.22	5.99
Illinois	28.95	5.68	22.86	1.72	8.77	2.98	13.31	7.92	7.52
Indiana	36.02	8.44	18.56	1.36	6.82	1.82	10.24	10.09	6.07
Iowa	34.59	9.58	19.11	0.76	6.39	1.76	13.50	9.27	4.96
Kansas	34.43	7.34	16.37	0.69	7.62	1.44	12.90	11.58	7.56
Kentucky	30.43	5.88	24.66	1.07	7.15	1.35	11.75	9.31	8.39
Louisiana	27.82	11.35	20.81	1.74	8.23	1.76	11.20	8.73	8.29
Maine	29.64	4.99	27.57	1.76	6.42	0.98	11.94	9.44	7.12
Maryland	31.44	4.54	20.23	2.05	10.37	2.46	12.96	8.17	7.70
Massachusetts	23.61	6.46	25.16	2.77	8.33	1.26	12.86	11.33	7.81
Michigan	34.25	8.55	22.97	0.63	8.57	1.42	9.32	8.58	5.44
Minnesota	29.77	6.51	24.29	1.66	6.41	2.17	11.71	9.90	7.17
Mississippi	30.84	12.99	20.78	1.09	6.18	0.99	10.87	10.57	5.31
Missouri	32.42	8.42	20.57	1.25	8.27	1.84	12.58	8.42	6.22
Montana	32.67	5.64	20.10	1.32	6.94	1.11	13.43	10.16	8.37
Nebraska	29.74	6.78	14.54	0.91	5.88	1.34	10.44	25.54	4.50
Nevada	25.98	6.52	17.29	1.09	12.77	3.24	14.24	9.53	8.56
New Hampshire	31.90	3.43	20.79	1.65	8.41	1.26	11.50	11.25	9.73
New Jersey	30.53	4.58	21.33	1.27	9.30	1.83	12.63	10.32	7.86
New Mexico	32.98	7.67	19.27	0.69	8.95	2.08	13.15	7.62	7.08
New York	23.56	7.68	26.57	2.03	8.56	1.39	13.79	9.54	6.61
North Carolina	32.40	10.19	18.44	1.26	7.77	1.53	9.84	13.75	4.63
North Dakota	33.58	3.24	20.12	1.38	5.42	1.90	13.66	14.13	6.41
Ohio	29.96	7.05	28.48	1.59	8.24	1.50	10.19	6.77	5.94
Oklahoma	33.83	7.82	21.00	1.02	7.96	1.65	10.97	9.52	6.18
Oregon	29.46	6.45	21.59	1.56	8.80	1.73	11.79	10.09	8.47

Pennsylvania	29.47	5.31	26.55	1.58	7.50	1.00	11.93	9.24	7.35
Rhode Island	27.36	4.98	27.65	1.90	9.36	1.42	9.76	7.09	10.39
South Carolina	31.07	12.57	19.24	0.89	6.85	1.23	8.27	13.79	5.73
South Dakota	30.98	4.49	17.05	1.06	6.50	2.33	16.35	12.82	8.38
Tennessee	25.21	8.98	19.42	1.31	7.01	1.45	9.70	22.12	4.62
Texas	34.79	7.65	17.27	0.93	8.57	1.38	11.80	10.92	6.68
Utah	33.25	5.78	14.98	1.03	7.28	2.06	11.63	17.92	6.09
Vermont	35.98	2.81	21.01	1.85	6.19	0.95	12.67	11.20	7.31
Virginia	34.61	7.66	15.90	1.52	9.61	1.93	13.91	7.58	7.04
Washington	27.46	7.17	20.97	1.26	7.78	2.01	12.24	15.77	5.30
West Virginia	31.88	5.45	27.15	0.94	5.10	1.21	12.35	7.93	7.98
Wisconsin	33.44	5.78	23.27	0.86	8.47	1.86	12.28	7.34	6.13
Wyoming	31.35	10.97	14.64	0.38	7.03	1.98	14.73	10.77	7.65

Table 6: Shares of Federal Direct Government Spending Categories over Total Federal Direct Government Spending by Geographical Location (1983-2008 average). Direct spending includes grants, salaries and wages, and procurement contracts

State	Education	Health	Social Welfare	Housing	Public Order and Safety	Parks, Libraries, Arts and Humanities	Infrastructure and Communication	Economic Affairs and Private Subsidies	Other Spending (Mostly Military/ Defense)	EPA	Federal Research excluded in other Categories (NSF, NASA)
Alabama	1.27	15.72	44.45	0.58	0.52		0.78	2.74	31.41	0.04	2.49
Alaska	0.96	8.68	20.88	1.58	1.15	0.30	5.47	1.97	56.66	0.40	1.95
Arizona	1.26	14.16	42.35	0.85	0.94	0.08	0.54	0.78	38.15	0.04	0.86
Arkansas	1.25	17.59	51.33	0.57	0.36	0.04	0.99	5.26	22.23	0.06	0.32
California	1.27	18.23	37.26	1.09	0.69	0.07	0.71	1.75	36.98	0.06	1.89
Colorado	1.43	11.98	34.91	2.24	0.68	0.14	0.95	5.51	39.85	0.30	2.01
Connecticut	0.88	17.22	37.71	0.95	0.40	0.03	0.66	0.59	40.78	0.04	0.74
Delaware	1.02	16.48	50.58	0.87	0.33	0.04	0.74	1.18	27.47	0.32	0.98
District of Columbia	5.38	8.51	26.39	2.32	12.19	1.51	0.82	4.41	35.21	1.36	1.90
Florida	0.95	20.38	46.87	0.41	0.88	0.03	0.64	0.53	28.29	0.03	0.99
Georgia	1.49	14.68	41.45	0.69	0.70	0.05	0.91	1.60	37.72	0.19	0.51
Hawaii	0.59	8.40	32.27	0.56	0.69	0.10	1.37	0.59	54.71	0.07	0.66
Idaho	1.38	12.35	47.13	2.77	0.34	0.08	1.55	9.73	23.72	0.20	0.75
Illinois	1.63	21.20	51.12	0.98	0.48	0.03	0.62	4.09	19.04	0.17	0.64
Indiana	3.76	17.16	49.65	0.67	0.41	0.02	0.73	2.82	24.06	0.06	0.67
Iowa	2.03	17.37	48.34	0.55	0.32	0.02	0.37	14.94	15.43	0.07	0.54
Kansas	1.57	15.41	41.20	0.44	0.43	0.03	0.74	9.10	30.39	0.25	0.43
Kentucky	1.51	16.20	49.68	0.77	0.59	0.00	0.68	4.59	25.55	0.07	0.37
Louisiana	2.01	17.30	43.80	0.96	3.32	0.04	1.24	3.09	26.82	0.06	1.35
Maine	1.16	15.43	45.16	0.82	0.46	0.05	0.60	0.53	35.23	0.10	0.46
Maryland	0.97	18.06	37.27	1.85	1.21	0.18	1.18	2.51	33.97	0.13	2.67
Massachusetts	1.67	22.13	37.00	1.18	0.50	0.13	0.80	0.69	34.31	0.27	1.32
Michigan	1.37	22.70	54.67	0.60	0.34	0.02	0.44	1.13	18.03	0.15	0.55
Minnesota	3.43	17.41	45.57	0.86	0.53	0.06	0.71	7.59	23.17	0.09	0.58
Mississippi	1.44	14.33	42.88	1.04	1.50	0.00	0.93	3.72	32.95	0.05	1.15
Missouri	1.38	15.19	40.68	0.77	0.44	0.07	0.70	4.09	36.27	0.06	0.36
Montana	1.51	14.39	44.49	0.92	0.39	0.16	1.46	15.71	19.46	0.27	1.26
Nebraska	3.28	14.68	42.74	0.53	0.37	0.04	0.52	13.94	23.25	0.12	0.54
Nevada	0.66	13.92	46.87	3.08	0.55	0.10	0.99	5.07	27.78	0.24	0.76
New Hampshire	1.11	15.25	45.87	0.85	0.49	0.07	1.23	0.62	33.40	0.22	0.89
New Jersey	1.02	20.35	48.57	0.90	0.73	0.03	1.21	0.46	25.96	0.15	0.62
New Mexico	1.87	11.43	36.16	2.16	0.68	0.08	5.35	7.91	33.23	0.14	0.99
New York	2.37	23.57	48.81	0.95	0.60	0.10	0.61	1.00	21.31	0.08	0.60
North Carolina	1.18	16.03	47.93	0.50	0.53	0.02	0.64	1.66	30.66	0.35	0.50
North Dakota	1.52	13.56	33.47	0.56	0.59	0.03	1.01	24.57	23.86	0.16	0.67
Ohio	1.78	20.40	49.77	1.03	0.27	0.02	0.41	1.74	23.54	0.14	0.90
Oklahoma	1.30	16.15	44.67	0.65	0.54	0.02	1.66	3.21	31.31	0.09	0.40
Oregon	1.31	17.81	57.40	0.83	0.49	0.05	1.61	1.36	18.24	0.16	0.74

Pennsylvania	1.68	22.79	50.99	0.64	0.48	0.04	0.49	1.23	21.00	0.13	0.53
Rhode Island	2.06	19.24	46.30	1.40	0.36	0.05	0.74	0.36	28.36	0.20	0.93
South Carolina	1.32	12.66	45.09	1.02	0.81	0.02	0.77	5.15	32.73	0.05	0.38
South Dakota	4.95	14.63	38.89	0.73	0.37	0.08	1.05	17.57	20.78	0.20	0.75
Tennessee	1.36	17.90	46.98	2.17	0.36	0.00	0.75	9.35	20.51	0.06	0.56
Texas	1.45	14.65	38.92	0.67	1.11	0.02	0.72	2.75	37.07	0.09	2.56
Utah	2.10	10.62	42.24	1.31	0.34	0.10	1.04	1.28	37.03	0.11	3.83
Vermont	2.38	17.73	49.01	0.87	1.61	0.07	0.71	0.97	25.52	0.20	0.92
Virginia	1.87	10.00	27.02	1.43	2.05	0.08	1.99	2.13	49.95	0.42	1.07
Washington	1.12	13.35	41.13	1.18	0.51	0.07	1.05	5.49	35.21	0.20	0.68
West Virginia	1.45	18.29	59.58	0.64	1.62	0.02	1.15	1.57	14.28	0.10	1.28
Wisconsin	2.15	19.61	53.92	0.64	0.53	0.03	0.64	3.38	18.29	0.13	0.68
Wyoming	1.25	13.19	46.97	1.17	0.26	0.29	1.09	0.00	34.18	0.20	1.41

Table 7: Shares of Federal Government Loans and Insurance Spending Categories over Total Federal Government Loans and Insurance Spending by Geographical Location (1983-2008 average)

State	Education	Housing	Public Order and Safety	Infrastructure and Communication	Economic Affairs and Private Subsidies	Other Spending (Mostly includes Military/ Defense)
Alabama	8.89	18.62	53.12	2.10	12.95	4.31
Alaska	1.33	45.23	28.63	5.00	10.27	9.53
Arizona	10.30	38.49	37.82	0.66	5.93	6.79
Arkansas	5.71	32.74	22.17	2.59	33.23	3.55
California	5.53	22.96	57.30	0.10	10.71	3.38
Colorado	8.70	41.91	23.85	1.43	16.14	7.96
Connecticut	6.48	19.04	67.03	0.21	5.51	1.71
Delaware	2.52	10.11	79.63	0.54	4.96	2.25
District of Columbia	35.27	31.65	5.69	0.00	25.29	2.05
Florida	0.58	3.18	94.23	0.08	1.20	0.72
Georgia	4.46	26.87	45.36	3.59	15.04	4.66
Hawaii	1.21	15.15	78.25	0.33	3.17	1.89
Idaho	5.98	33.11	26.48	1.12	28.07	5.23
Illinois	10.31	31.12	25.14	1.32	28.84	3.26
Indiana	21.60	26.89	22.23	1.07	24.76	3.45
Iowa	8.24	7.01	9.41	1.41	72.71	1.21
Kansas	8.56	18.20	19.38	1.56	48.42	3.86
Kentucky	9.40	23.06	36.51	5.03	21.98	4.00
Louisiana	0.84	3.07	92.09	0.47	3.09	0.44
Maine	10.46	22.09	50.49	2.73	9.82	4.35
Maryland	3.89	43.40	43.25	0.26	2.97	5.99
Massachusetts	16.53	13.45	60.64	0.31	7.25	1.79
Michigan	14.40	34.94	28.37	1.61	16.34	4.32
Minnesota	13.88	29.22	8.28	1.72	43.90	2.98
Mississippi	2.83	11.35	60.61	1.54	22.00	1.66
Missouri	10.59	31.48	28.06	2.02	23.68	4.15
Montana	7.20	23.06	15.74	2.03	48.90	3.05
Nebraska	8.94	10.37	17.58	0.54	59.74	2.83
Nevada	1.77	46.57	39.50	0.28	3.70	8.19
New Hampshire	13.22	26.94	41.51	2.68	10.00	5.63
New Jersey	2.62	10.18	84.58	0.06	1.54	1.01
New Mexico	6.88	32.81	39.32	2.90	10.30	7.78
New York	15.38	18.92	54.26	0.24	10.14	1.05
North Carolina	2.84	16.66	59.73	1.66	14.91	4.20
North Dakota	3.37	8.22	16.52	2.25	68.71	0.91

Ohio	12.90	37.98	25.70	1.10	16.84	5.45
Oklahoma	9.53	29.48	33.02	2.94	19.24	5.78
Oregon	8.70	28.44	45.36	1.17	12.68	3.62
Pennsylvania	19.06	20.60	51.60	1.04	4.87	2.81
Rhode Island	11.47	13.86	69.34	0.19	3.67	1.46
South Carolina	1.68	6.54	84.36	1.42	4.23	1.77
South Dakota	6.36	12.35	9.50	3.43	66.36	1.97
Tennessee	8.79	44.44	24.45	1.85	14.20	6.25
Texas	2.69	13.04	74.13	0.45	7.57	2.13
Utah	7.57	57.18	10.26	0.97	18.98	5.04
Vermont	24.41	12.28	40.69	2.59	17.49	2.49
Virginia	4.63	27.56	52.62	1.68	5.22	8.28
Washington	7.08	35.38	34.15	0.38	14.58	8.41
West Virginia	12.10	12.37	65.06	1.80	6.27	2.39
Wisconsin	24.54	18.26	20.48	2.26	28.82	5.58
Wyoming	5.70	35.78	29.41	2.75	20.51	5.81

Table 8: Shares of State & Local Government Spending Categories over Total State & Local Government Spending over Time and Geographical Location

State	Education			Health			Social Welfare & Security		
	1983-1989	1990-1999	2000-2008	1983-1989	1990-1999	2000-2008	1983-1989	1990-1999	2000-2008
Alabama	31.89	29.73	32.71	12.77	14.80	13.28	11.84	17.76	23.00
Alaska	21.17	20.82	21.62	2.77	3.30	2.86	9.29	15.62	21.39
Arizona	31.17	29.89	28.87	4.15	4.30	5.41	10.85	17.04	22.16
Arkansas	36.99	34.28	35.08	8.57	8.83	6.65	16.77	21.90	25.82
California	26.13	24.33	26.87	7.25	7.90	7.28	20.86	21.91	24.24
Colorado	30.80	30.67	30.12	6.53	5.42	6.09	14.97	17.91	21.78
Connecticut	27.88	26.67	28.87	6.33	6.76	6.96	18.74	23.37	25.33
Delaware	34.58	33.50	32.10	4.59	5.04	5.59	11.10	16.24	20.48
District of Columbia	12.81	12.15	15.43	7.36	8.15	7.02	19.04	24.90	20.71
Florida	28.21	26.77	26.83	9.22	8.51	7.13	9.57	14.43	20.75
Georgia	28.52	30.43	34.67	14.84	11.84	8.08	12.55	17.62	22.49
Hawaii	24.17	21.21	26.47	6.18	6.63	8.08	17.63	18.60	22.09
Idaho	33.30	33.85	32.04	8.72	8.37	7.49	15.43	18.22	23.90
Illinois	29.25	28.78	28.91	5.48	5.84	5.67	20.27	21.81	26.05
Indiana	36.75	36.64	34.76	9.09	9.07	7.22	15.03	17.99	21.96
Iowa	34.99	34.69	34.17	8.89	9.89	9.76	15.64	17.80	23.26
Kansas	34.23	34.71	34.28	7.26	7.95	6.74	12.99	14.91	20.63
Kentucky	30.88	30.23	30.30	5.84	5.83	5.98	18.28	24.41	29.90
Louisiana	27.15	27.58	28.61	10.20	12.33	11.15	17.82	21.18	22.71
Maine	31.28	30.43	27.47	4.24	4.70	5.90	22.90	27.80	30.95
Maryland	30.56	31.37	32.20	4.29	4.22	5.07	16.69	20.04	23.19
Massachusetts	23.50	22.48	24.93	7.77	6.96	4.90	22.60	25.31	26.98
Michigan	32.06	34.39	35.79	8.82	8.40	8.52	22.53	22.41	23.92
Minnesota	29.51	29.77	29.97	7.20	7.58	4.78	19.13	22.50	30.29
Mississippi	31.85	31.41	29.41	14.10	13.56	11.49	15.12	19.22	26.92
Missouri	33.16	32.82	31.39	9.43	7.91	8.20	14.71	19.84	25.94
Montana	33.48	33.38	31.25	4.79	5.45	6.51	17.97	20.54	21.29
Nebraska	28.00	30.81	29.90	7.40	6.62	6.47	9.36	13.29	19.97
Nevada	23.45	25.32	28.69	7.33	6.64	5.76	15.87	18.00	17.60
New Hampshire	31.63	30.90	33.23	4.93	3.03	2.70	13.53	23.08	23.89
New Jersey	29.46	30.13	31.80	5.16	4.32	4.43	17.17	21.28	24.63
New Mexico	34.71	32.12	32.60	7.25	8.54	7.03	12.40	18.19	25.81
New York	24.18	23.23	23.45	8.45	7.91	6.84	21.78	26.27	30.64
North Carolina	34.31	31.32	32.12	8.27	11.39	10.36	12.97	17.60	23.63
North Dakota	34.70	33.70	32.57	4.69	2.97	2.40	15.84	20.55	22.98
Ohio	30.48	29.80	29.73	7.14	7.04	6.98	25.61	27.59	31.69

Oklahoma	33.52	33.39	34.56	8.53	8.96	5.99	16.91	20.32	24.95
Oregon	31.77	29.81	27.28	5.32	6.64	7.11	14.96	20.21	28.27
Pennsylvania	29.20	30.08	28.99	5.06	5.09	5.76	22.67	25.30	30.94
Rhode Island	28.44	27.06	26.85	6.49	5.12	3.65	23.16	26.18	32.77
South Carolina	33.40	30.31	30.10	11.68	13.73	11.98	12.69	19.45	24.11
South Dakota	31.10	31.76	30.02	4.61	4.66	4.21	11.74	16.11	22.22
Tennessee	24.55	24.98	25.98	8.85	9.72	8.28	12.84	17.55	26.62
Texas	35.05	34.09	35.35	7.44	8.22	7.17	11.12	17.18	22.16
Utah	31.06	33.53	34.64	4.89	5.76	6.48	11.33	14.32	18.55
Vermont	34.91	35.99	36.80	3.76	2.38	2.54	15.90	20.61	25.43
Virginia	35.55	33.95	34.60	8.08	7.33	7.69	11.60	15.42	19.78
Washington	26.32	27.58	28.21	5.51	7.14	8.49	17.56	20.36	24.31
West Virginia	32.67	31.72	31.44	6.41	5.58	4.55	21.64	28.62	29.79
Wisconsin	34.19	34.22	31.99	6.66	5.50	5.41	20.76	21.89	26.77
Wyoming	33.49	31.83	29.14	9.73	11.04	11.86	10.28	14.59	18.10

Table 9: Shares of Federal Direct Spending Categories over Total Federal Direct Spending by Time and Geographical Location
Direct spending includes grants, salaries and wages, and procurement contracts

State	Education			Health			Social Welfare & Security		
	1983-1989	1990-1999	2000-2008	1983-1989	1990-1999	2000-2008	1983-1989	1990-1999	2000-2008
Alabama	1.87	1.18	0.89	12.24	16.21	17.90	46.57	45.67	41.45
Alaska	0.93	0.82	1.15	6.63	9.27	9.63	18.30	22.85	20.71
Arizona	1.51	0.85	1.51	10.63	15.54	15.37	40.56	45.01	40.78
Arkansas	1.19	1.25	1.30	13.01	18.44	20.21	48.37	53.66	51.05
California	1.37	1.26	1.20	12.74	17.72	23.06	31.89	39.29	39.18
Colorado	1.51	1.42	1.39	9.71	11.90	13.84	34.33	34.92	35.34
Connecticut	1.06	0.83	0.79	10.30	18.65	21.03	31.67	42.44	37.14
Delaware	0.91	1.02	1.12	11.96	16.71	19.74	46.51	50.87	53.41
District of Columbia	8.09	4.84	3.86	11.75	8.74	5.75	41.45	25.54	15.63
Florida	1.10	0.84	0.96	14.86	20.16	24.94	46.38	47.99	46.01
Georgia	1.22	1.01	2.23	9.23	14.74	18.85	40.01	42.87	41.00
Hawaii	0.41	0.69	0.63	5.37	8.46	10.68	28.11	34.56	32.97
Idaho	1.75	1.51	0.96	11.38	12.78	12.61	50.64	47.36	44.15
Illinois	2.41	1.48	1.20	17.11	21.68	23.85	52.03	52.87	48.47
Indiana	1.86	4.36	4.57	12.64	18.14	19.57	48.74	51.61	48.18
Iowa	2.04	2.05	1.99	14.02	17.47	19.88	48.26	48.55	48.17
Kansas	1.87	1.25	1.69	11.22	16.42	17.55	36.94	43.97	41.43
Kentucky	1.48	1.39	1.65	13.02	15.92	19.00	53.85	51.50	44.42
Louisiana	2.08	1.46	2.58	10.75	18.25	21.35	43.56	46.59	40.88
Maine	1.49	1.19	0.86	12.87	15.25	17.62	44.38	44.29	46.72
Maryland	1.20	0.90	0.87	11.64	18.07	23.03	39.03	39.51	33.40
Massachusetts	1.88	1.59	1.60	14.80	22.37	27.58	32.54	39.12	38.10
Michigan	2.05	1.23	0.98	18.39	23.41	25.27	53.62	56.48	53.47
Minnesota	4.14	3.77	2.49	12.32	17.47	21.30	41.20	47.48	46.85
Mississippi	1.69	1.38	1.32	10.39	15.09	16.56	40.50	45.53	41.79
Missouri	1.20	0.94	2.01	10.61	15.75	18.13	35.80	42.52	42.42
Montana	1.44	1.77	1.28	11.07	14.62	16.71	45.60	43.84	44.33
Nebraska	2.42	2.97	4.29	11.47	15.31	16.48	42.42	44.73	40.76
Nevada	1.11	0.55	0.41	12.59	13.91	14.96	43.79	47.99	48.01
New Hampshire	0.65	1.32	1.24	10.78	16.31	17.56	39.60	48.15	48.20
New Jersey	1.63	0.82	0.77	15.04	20.39	24.44	45.98	50.22	48.76
New Mexico	2.99	1.43	1.48	11.88	11.37	11.16	42.91	35.42	31.74
New York	3.41	2.28	1.66	17.06	23.81	28.36	45.49	51.00	48.96
North Carolina	1.46	1.06	1.09	11.77	16.43	18.89	46.35	48.94	48.04
North Dakota	1.26	1.39	1.86	10.57	15.27	13.99	31.14	36.82	31.57
Ohio	1.72	1.32	2.33	14.64	20.23	25.08	49.45	51.77	47.80

Oklahoma	1.44	1.42	1.05	12.06	16.80	18.62	44.03	45.87	43.83
Oregon	1.49	1.43	1.04	15.67	18.08	19.16	58.77	57.92	55.75
Pennsylvania	2.19	1.43	1.55	17.16	23.28	26.61	52.08	52.51	48.45
Rhode Island	1.48	1.70	2.93	14.12	18.80	23.70	44.28	47.94	46.04
South Carolina	1.04	1.14	1.72	9.37	12.58	15.31	44.29	45.28	45.51
South Dakota	2.83	2.09	9.79	11.94	16.65	14.47	41.00	41.78	34.05
Tennessee	1.91	1.21	1.09	15.29	17.48	20.40	52.21	46.88	43.02
Texas	1.51	1.49	1.37	10.94	15.50	16.58	35.83	41.69	38.23
Utah	2.25	2.23	1.83	7.88	11.02	12.30	38.82	44.62	42.27
Vermont	2.21	2.66	2.21	14.94	18.54	19.00	48.85	52.32	45.46
Virginia	1.46	1.51	2.66	8.04	10.64	10.91	28.80	28.65	23.43
Washington	1.61	1.01	0.86	9.94	13.71	15.61	38.42	43.00	41.18
West Virginia	2.11	1.42	0.98	14.42	18.74	20.80	65.63	59.82	54.60
Wisconsin	2.64	2.06	1.88	16.38	20.62	21.00	53.42	55.50	52.54
Wyoming	1.17	1.54	0.98	10.44	13.89	14.55	46.39	48.79	45.40

Table 10: Shares of Federal Government Loans and Insurance Spending Categories over Total Federal Government Loans and Insurance by Time and Geographical Location

State	Education		
	1983-1989	1990-1999	2000-2008
Alabama	4.16	10.48	10.79
Alaska	0.42	0.54	2.92
Arizona	4.54	6.67	18.81
Arkansas	2.48	5.84	8.07
California	5.56	4.29	6.90
Colorado	4.40	8.22	12.59
Connecticut	8.89	5.09	6.15
Delaware	2.91	2.18	2.61
District of Columbia	36.99	20.08	50.81
Florida	0.60	0.46	0.71
Georgia	2.05	4.32	6.51
Hawaii	1.91	0.79	1.13
Idaho	3.96	5.57	7.99
Illinois	8.26	8.38	14.05
Indiana	6.87	39.57	13.09
Iowa	4.07	8.19	11.53
Kansas	14.03	3.55	9.86
Kentucky	3.82	10.09	12.97
Louisiana	0.45	0.87	1.12
Maine	8.84	10.85	11.29
Maryland	3.94	3.08	4.75
Massachusetts	15.45	17.27	16.55
Michigan	10.64	13.08	18.80
Minnesota	21.38	9.70	12.70
Mississippi	1.87	2.89	3.51
Missouri	6.07	9.27	15.57
Montana	3.58	7.69	9.48
Nebraska	7.31	9.94	9.09
Nevada	1.76	0.86	2.78
New Hampshire	10.79	12.97	15.39
New Jersey	3.55	2.24	2.33
New Mexico	4.89	7.78	7.44
New York	20.88	12.16	14.67
North Carolina	1.46	2.80	3.95
North Dakota	2.32	3.28	4.28
Ohio	10.46	11.21	16.68

Oklahoma	3.44	10.43	13.26
Oregon	8.43	8.38	9.27
Pennsylvania	14.87	20.59	20.62
Rhode Island	13.93	9.32	11.95
South Carolina	0.97	1.87	2.02
South Dakota	5.14	6.41	7.26
Tennessee	4.52	8.88	12.03
Texas	1.64	3.20	2.92
Utah	5.75	7.96	8.56
Vermont	19.38	25.75	26.83
Virginia	2.47	4.79	6.13
Washington	4.77	7.78	8.10
West Virginia	15.47	7.20	14.94
Wisconsin	17.93	30.79	22.76
Wyoming	6.20	2.57	8.80

Table 11: Education – Complementarities and Substitution of Spending Shares Government Levels

	State Education Spending	Federal Direct Education Spending
Federal Direct Education Spending	-0.1068***	1
Federal Assistance Education Spending	-0.1025***	0.3001***

Table 12: Health and Social Security & Welfare – Complementarities and Substitution of Spending Shares Government Levels

	Federal Direct Health Spending
State Health Spending	-0.0718***
	Federal Direct Social Security & Welfare Spending
State Social Security & Welfare Spending	0.1878***

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Chapter 3: Fiscal spending for economic growth in the presence of imperfect markets

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1. Introduction

This paper shows theoretically and empirically that under imperfect credit markets and increasing social returns to human capital, government spending on social and public goods (including education, health, social transfers, and pure public goods) promotes a faster rate of economic growth while government spending on non-social subsidies (credit subsidies to firms, farm subsidies, and many others) is toxic for growth. The basic conceptual story is simple: Credit rationing affects a subset of households, which leads to aggregate underinvestment and scarcity of human capital, but aggregate investment in physical capital is unaffected even if a large portion of the firms are affected by credit rationing.

The essence of this asymmetry emanates from imperfect substitutability of human capital investment across households in contrast to perfect substitutability of physical capital across firms. Underinvestment in human capital by one household (due to credit rationing) cannot be offset by a corresponding increase in investment by another household because other household factors (innate ability) are fixed and cannot be transferred across households. Thus credit market imperfections affecting households reduce the aggregate level of human capital (Galor and Zeira, 1993); even more importantly, to the extent that human capital facilitates the creation and adaptation of new productive ideas, a lower level of aggregate human capital reduces total factor productivity growth, which may cause a permanent fall in the rate of economic growth. On the other hand, a reduction in physical capital in one firm (due to credit rationing) can be offset by a corresponding increase in another firm (not subject to credit rationing) because other factors (labor) can move freely across firms. Thus the allocation of physical capital, and therefore credit, across firms may, under certain plausible conditions to be rigorously examined below, be immaterial for economic growth over the long run.

The implication for government spending is clear. As long as spending on social goods mitigates the negative effects of credit rationing on households' investment in human capital, an increase in social spending will increase human capital and, potentially, the rate of productivity growth. In contrast, fiscal spending on non-social subsidies, even if directed to credit-constrained firms, may only affect the distribution of investments between credit-constrained and unconstrained firms but not the aggregate level of investments in physical capital by firms. Moreover, non-social government subsidies increase the incentives for firms to devote scarce human capital to rent-seeking activities needed to grab such subsidies subtracting human capital not only from directly productive activities but, more importantly, from the process of creation and adaptation of new productive ideas, perhaps the most vital role of human capital (Murphy et.al., 1991; Acemoglu, 1996). Hence non-social fiscal subsidies reduce the rate of growth of total factor productivity leading to a permanent reduction of the rate of economic growth. Furthermore, social spending in comparison to non-social subsidies may not induce rent-seeking to the same extent because the benefits of social spending are widely distributed, whereas the costs of lobbying are private.

Hence, one may expect that, unlike non-social subsidies, social spending will not have a large effect on rent-seeking.[10]

We first formalize these ideas by integrating several strands of a vast literature on market failures to develop a model that directly links fiscal expenditure patterns with productivity growth and investment. Specifically, we use ideas from the literature on credit market failure and human capital investment (Galor and Zeira, 1993), human capital accumulation and its spillovers on productivity growth (Acemoglu, 1996; Murphy et. al., 1991), and the flexibility of firms in adapting to market imperfections affecting only one factor of production (Eswaran and Kotwal, 1986; Carter and Barham, 1996). We empirically test the hypothesis presented at the outset of this paper by establishing an unusually close link between the theoretical and empirical models by using a new empirical strategy that mitigates some of the most important objections to cross-country analyses raised in the recent literature (e.g., Durlauf et.al., 2005).

Empirically measuring the strength of the effect of fiscal mechanisms on growth has been the object of many studies. A weakness of this literature has been the general lack of a solid conceptual framework that would establish a clear taxonomy of expenditures to generically distinguish pro-growth spending patterns from the rest. This conceptual weakness is probably a reason for the non-robust findings across the literature. Barro (1991), and Levine and Renelt (1992), for example, find that government spending has a negative effect on growth, while Ram (1986) finds a

[10] But there are exceptions. Human capital is, at times, allocated towards garnering benefits that are social. However, the relationship between rent-seeking and rents for social goods might even be negative. When government social spending is low, more human capital might be allocated towards pressuring government to increase such spending (protesting, petitioning, addressing community needs not remedied by the government, etc).

positive correlation. Still others find that there is no correlation between both variables (Kormendi and Meguire, 1985; Sala-i-Martin, 1997). More recent analyses have shifted the attention to the composition of government expenditures (Easterly and Rebelo, 1993; Islam, 1995; Devarajan et al., 1996). However, these studies have not yielded more definitive results than those that use aggregate spending.[11]

We distinguish *pro-market expenditures (PME)* that alleviate the effects of market failure from *market-restricting expenditures* (*RME*) that do nothing to alleviate market failures and may instead exacerbate them. *PME* thus include social subsidies to households (education, health, and a variety of social protection programs), expenditures on knowledge creation and diffusion, as well as on pure public goods. *RME* include most non-social subsidies, such as commodity market subsidies, energy subsidies, credit subsidies and grants to corporations, loan guarantees, and bailouts of failed private financial institutions, among many others[12]. We empirically show that the quantitative effect of shifting the composition of fiscal spending from *RME* to *PME* on economic growth is dramatic. We also perform more disaggregated empirical estimations, by splitting *PME* into government social spending and spending in non-

[11] In general the empirical literature on the returns to public services is highly debated. Aschauer (1989) concludes that public capital is highly productive and attributes the decline in productivity in the USA to the decline in new public capital. However, some cast doubt on Aschauer's findings, arguing that the results are not robust and are highly overestimated (Aaron, 1990). Others agree that the public investment has, indeed, been productive (see Romp and De Haan, 2007, for a survey). However, new investment is unlikely to match historical productivity levels. In general, as shown by the survey of Romp and De Haan (2007), the estimated elasticity of government investment is highly variable, suggesting time effects and/or highly non-linear relationships.

[12] An illustration of the magnitude of *RME* is provided by the following examples: Worldwide farm subsidies reached $500 billion in 2001, 1.5% of the world GDP or 4.5% of total government revenues (Anderson et. al., 2006). Governments are estimated to spend in the range of 1 to 5% of annual GDP on fuel subsidies, tax exemptions and related subsidies mostly benefiting large firms (Coady et. al., 2006). The direct cost to US taxpayers of the S&L financial crises of the late 1980s has been estimated at $150 billion mostly spent over the period 1989-92 or about 4% of the total federal spending in each year (Curry and Shibut, 2000).

social public goods and decomposing their effects on growth between a direct output effect and an investment effect, showing that most of the positive effect of *PME* on growth can indeed be attributed to the effect of spending on social goods.

The theoretical and empirical investigation of the relationship between government spending composition and economic growth is important especially given the influence of economic crises on both the size and composition of government expenditures. In times of economic crises, many governments use fiscal spending as a mechanism to stimulate the economy. Fiscal stimulus not only entails more or less temporary surges in fiscal spending but also significant revisions of governments priorities. Periods of crisis, when massive fiscal spending expansion can be easily justified, are propitious opportunities to change relative spending priorities without having to reduce politically sensitive programs (Higgs, 1987). While the increased government spending may turn out to be temporary, the changes in the composition of fiscal spending often become permanent. [13] In view of this, one may expect that the 2008-2009 financial crisis may cause significant changes in the structure of government spending composition although the direction of change is unclear. Calls for austerity measures, particularly cuts in social expenditures in Europe and the US, further underline the importance of the present study.

[13] For example the US government used the unprecedented fiscal spending expansion designed to deal with the Great Depression to dramatically increase social protection and welfare programs as well as education and other related programs resulting in an increase in the share of government spending on social programs from 2.48% in 1929 to 10.72% in 1940. In Korea, fiscal spending in social security and welfare increased from 7.8% of the total government expenditures in years prior to the 1997-98 Asia crisis to 13.5% by 2003-2005, and in Thailand from less than 4% to almost 9% in 2003-05 (Asian Development Bank, 2009).

2. Conceptual Model and the Central Hypothesis

The model describes the responses of firms and households to fiscal policy and the subsequent impact on economic growth under imperfect credit markets. We first show the optimal human capital investment choice by credit-constrained and unconstrained households, and the resulting implications for aggregate supply of human capital in the economy. We then present the firm's maximization problem and the ensuing optimal allocation of resources for constrained and unconstrained firms towards production and rent- seeking activities, and the implications for aggregate factor demand in the economy. Finally, we delineate the equilibrium for factor markets, and the implications for output and economic growth for the economy.

The analysis assumes two types of market failures: *(i)* Asymmetric information and moral hazard, which foster an environment where collateral requirements are essential to access credit, and transaction costs in credit markets, which introduce a wedge between lending and borrowing rates (Rothschild and Stiglitz, 1976; Stiglitz and Weiss, 1981; Hayashi, 1985)[14]. *(ii)* Human capital spillovers in the generation and adoption of knowledge (Hoff and Stiglitz, 2000; Acemoglu, 1996; Murphy et. al., 1991).

[14]Recent empirical literature has shown that credit market failure is pervasive in both poor countries (Haque and Montiel, 1989) and rich ones (Attanasio et. al., 2008; Grant, 2007).

2.1 Assumptions.

We assume that workers or households invest in human capital and firms invest in physical capital. Credit rationing affects only some of the households and firms (presumably the least wealthy), while others can borrow freely in domestic or even international capital markets (Galor and Zeira, 1993; Whited, 1992). To sharpen the analysis, we define constrained firms and households as those with net wealth below a certain critical level, which impedes access to the formal capital markets.

Additional assumptions are: (A.1) The economy is open to international capital markets implying that a segment of firms and households (i.e., the financially "unconstrained" firms and households) face a fixed price for capital, while international mobility of human capital is restricted meaning that its level is endogenous to the economy.[15] (A.2) Firms produce a single output using physical capital and various types of labor skills, using a constant-returns-to-scale production function, and are price takers in input and output markets. The production technology is weakly separable in physical capital and the various types of labor skills. (A.3) The various labor skills are perfect substitutes for each other in the firms' production function up to a scale factor. One hour of a high-skilled worker is equivalent to more than one hour of work of a lower skilled worker. (A.4) Workers invest financial resources to enhance their human capital through a production function, which is subject to decreasing marginal returns

[15] International labor mobility is not in reality fully restricted as we assume here as shown by the significant migration flows occurring in certain contexts. However, the qualitative analysis is still valid as long as international labor flows are affected by a degree of restrictions while financial and physical capital flows freely in and out of the country.

due to the existence of a fixed factor (workers' innate ability). (A.5) Due to credit transaction costs, the banks' lending interest rate is higher than their borrowing rate.

Assumption A.1 is consistent with the increasing integration of world capital markets that have taken place over the last three decades and with the permanence of severe restrictions to international labor migration. A.2 is fairly standard in the literature. Assumption A.3 is less so, but is made to reduce the dimension of the human capital market effectively to just one market. This assumption, in combination with A.2, allows for the existence of a composite wage rate and a human capital aggregator function in the firms' production function. Assumption A.4 is also common in the literature (Galor, 2000). Assumption A.5 as we shall see ensures that credit-constrained firms relying on their own financial capital are not entirely displaced by unconstrained firms.

2.2 Human capital investment

Each worker or household has one unit of human capital. By investing h dollars in period 0, she can enhance her human capital by a function $\psi(h)$ and thus her total human capital in period 1 is $1+\psi(h)$. The function $\psi(h)$ is increasing and, by assumption (A4), strictly concave in h . We assume that $\psi(0)=0$. Each worker maximizes her utility over two periods. In period 0 we assume without loss of generality that the worker earns a given wage rate, w_0, and has a fixed level of wealth, s_0. For a worker that invests in human capital in period 0, her wage in period 1 is $w_1=(1+\psi(h))w_0$.

Financially-unconstrained workers can borrow unlimitedly at a fixed lending rate, r^f. Constrained workers cannot borrow and consequently have to finance their human capital investment (and consumption) out of their own wealth. Whether or not a worker is financially constrained depends on her initial level of wealth. The minimum wealth level to access credit markets is $\overline{s}$ and hence only workers with $w_0 + s_0 \geq \overline{s}$ are able to borrow freely at the rate r^f,while all other workers cannot borrow and consequently are financially-constrained.

The following lemma follows from the above setting:

Lemma 1. *(i) Human capital investment by financially-constrained workers in period 0* (h^c) *is lower than that of unconstrained workers* (h^u) *and, consequently, human capital and the wage of unconstrained workers in period 1 is higher than that of constrained workers, that is,* $\psi(h^u) > \psi(h^c)$*, which implies that* $w_1^u > w_1^c$*. (ii) While the level of human capital investment by financially-unconstrained workers is unaffected by their initial wealth, human capital investment by financially-constrained workers is increasing in their wealth level.*

Proof*. See Appendix I.*

Consider the effect of an exogenous increase in the level of wealth of a worker in period 0: The additional wealth reduces the internal marginal cost of capital for the financially-constrained worker and hence the worker will spend part of the additional wealth in financing more investment in human capital and part of it to increase consumption. By contrast, for financially-unconstrained workers, their increased wealth affects neither their marginal (market) cost of capital nor the rate of return to human capital. Hence, they do not change their investment level and instead devote their entire additional wealth to consumption.

Using assumption A.4 it follows that for a financially-constrained worker c, the level of human capital in period 1 is $1+\psi(h^c(s_0^c, w_0))$, where s_0^c is the wealth of worker c in period 0 while the unconstrained worker u, has human capital equal to $1+\psi(h^u(r^f, w_0))$. Suppose there are a fixed number of workers equal to N, of which C_0 have levels of wealth below the critical level ($\overline{s}$) in period 0 and $N - C_0$ have wealth levels sufficient to allow full access to the credit market. Without loss of generality we can order workers according to their wealth level from the poorest to the richest. Then the economy's total supply of human capital in period 1 is

(1)

$$L^S(s_0^1, s_0^2, ..., s_0^{C_0}; C_0, w_0) = \sum_{c=1}^{C_0}(1+\psi(h^c(s_0^c, w_0)) + \sum_{u=C_0+1}^{N}(1+\psi(h^u(r^f, w_0)).$$

Thus, the aggregate supply of human capital in period 1 is a function of the wealth levels, the wage rate, and number of financially-constrained workers in period 0. The fact that $h^c(s_0^c, w_0) < h^u(r^f, w_0)$ for all $s_0^c < \overline{s}$ implies that $L^S(s_0^1, s_0^2, ..., s_0^C; C_0, w_0)$ is decreasing in C_0, and also $\partial h^c / \partial s_0 > 0$ means that L^s is increasing in s_0^c (for all $c = 1, 2, ..., C_0$).

Consider a lump-sum transfer in period 0 to each financially-constrained worker equal to m. From (1) it follows that the transfer has two effects on L^s: (i) an intra-marginal effect caused by increasing human capital of workers that remain financially constrained after the transfer, and (ii) a discrete effect on workers whose level of initial wealth is such that the transfer allows them to "jump" into the unconstrained regime, which we call the *"investment jump"* effect. The intra-marginal effect is equal to $\sum_{c=1}^{C_0}(\partial L^s/\partial s_0^c)(\partial s_0^c/\partial m)>0$ while the jump effect is equal to $(\partial L^s/\partial C_0)(\partial C_0/\partial m)$, which is also positive because $\partial C_0/\partial m<0$. Thus, the potency of subsidies to financially-constrained workers in raising their human capital can be quite large. For those workers that are near the border of the financial regime, even a small lump-sum subsidy can have a dramatic effect on investments in human capital by propelling them into an unconstrained financial regime. The following lemma summarizes the implications of the previous analysis.

Lemma 2. *(i) Workers facing binding credit constraints invest sub-optimally in human capital, which cannot be compensated by increased human capital investments by workers that are unaffected by credit constraints. (ii) Aggregate supply of human capital, L^S, is reduced by the existence of credit constraints affecting a subset of workers; (iii)* S*ubsidies to workers in period 0 increase the aggregate supply of human capital in period 1 if at least some of them are financially constrained, possibly inducing an investment jump effect among a subset of workers.*

2.3 Firms' resource allocation, lobbying and aggregate output

First consider financially-unconstrained firms. We assume that they use human capital and physical capital to produce new value (output) and for rent-seeking activities necessary to grab part of the (non-social) subsidies that the government makes available to firms. Consider a firm's production function in period 1. By assumptions A.2 and A.3 we can write firm j's production function as

$$y_j = af(k_j, l_j),$$

where y_j denotes firm j's output, k_j is the firm's physical capital, and $l_j = \sum_{n=0}^{\overline{n}} (1+\psi^n(h^n))l_j^n$ is the firm's total human capital used in producing output. l_j is an increasing and homogenous of degree one function of the $\overline{n}+1$ labor skills used by the firm in the production of y_j (all variables correspond to period 1; we omit the subscripts indicating time period). Assumptions A.2 and A.3 also imply that the function $f(\ )$ is homogenous of degree one in k_j and l_j. Total factor productivity, a, is taken as given by firms.

The rent-capturing function is assumed to be a function of the firm lobbying efforts using physical capital (k_j^M) and human capital (l_j^M). In addition, the effectiveness of such effort depends on the availability of non-social government subsidies to be allocated to firms (M). Thus, we assume that the (gross) rent-capturing function of firm j is,

$$R_j = R(k_j^M, l_j^M; M)$$

This function is assumed to be increasing, concave and linearly homogenous in k_j^M, l_j^M and M. Thus, firms need to divert factors of production for lobbying in order to share part of the rents made available by the government. The assumption of linearly homogeneity of the function $R(k_j^M, l_j^M; M)$ implies, as we show below, that the chosen levels of k_j^M and l_j^M are proportional to M and therefore that a doubling of M, for example, would result in a doubling of the factors used in lobbying and hence in a doubling of gross rents captured by firm j. Profit maximization of the financially unconstrained firm including both production and rent-grabbing activities is,

$$\pi \equiv \max_{k_j, l_j, k_j^M, l_j^M} \{af(k_j, l_j) + R(k_j^M, l_j^M; M) - r^f(k_j + k_j^M) - w(l_j + l_j^M)\},$$

where r^f is the exogenous cost of capital given by international capital markets and w is the composite wage of the human capital composite factor.

Financially-constrained firms are assumed to solve a similar problem except that they are unable to lobby, which means that they do not share the rents. [16] That is, constrained firms merely maximize profits emanating from their productive activities.

Lemma 3. *(i) The equilibrium human capital-to-physical capital ratio employed in productive activities is identical for financially-unconstrained and constrained firms,* $(l_c / \chi_c)^E = (l_j / k_j)^E$ *, where* χ_c *is the wealth of financially-constrained firms and* l_c *is human capital employed by financially-constrained firms. (ii) The equilibrium human capital-to-physical capital ratio is* $(l_j / k_j)^E = \phi(r^f / a)$ *where* ϕ *is a strictly increasing*

[16] The assumption that financially-constrained firms are unable to lobby is justified by the fact that they are small and by definition face severe capital limitations.

function and is fixed for given levels of (r^f / a). *(iii) The ratio of lobbying human capital to government non-social subsidies,* l_j^M / M *, and lobbying physical capital to government non-social subsidies,* k_j^M / M *, are also fixed as determined by* $l_j^M / M = \zeta^L(w^E, r^f)$ and $k_j^M / M = \zeta^K(w^E, r^f)$ *respectively, where* ζ^L *(*ζ^K*) are decreasing (increasing) in* w^E *and increasing (decreasing) in* r^f *and* $w^E = w^E(a, r^f / a)$ is increasing in a and decreasing in r^f .

Proof*. See Appendix I.*

Lemma 3 provides two seemingly paradoxical results that need to be heuristically explained. The first one is the result that the human capital-to-physical capital ratios are identical for unconstrained and constrained firms. That is, the condition $af_1(l_j / k_j) = r^f$ is valid not only for financially unconstrained firms but also for constrained firms; suppose constrained firms' marginal product of physical capital is higher than the price of capital as a consequence of their low levels of owned capital, which means that $l_j / \chi_j > l_j / k_j$. This must imply that the marginal product of labor in the constrained firms is lower than the wage rate. Hence employment by constrained firms must fall, which causes the l_j / χ_j ratio to fall until the human capital-to-physical ratio becomes equal to that of the unconstrained firms. Thus, the mechanism to reach this condition is through adjusting labor allocation between constrained and unconstrained firms, not capital. For financially-constrained firms the condition $af_1(l_c / \chi_c) = r^f$ holds by making $l_c < l_j$.

The second result needing an intuitive explanation is why the unique human capital – physical capital ratio is fixed. From the first order conditions for the unconstrained firms' maximization problem: $af_2(l_j/k_j)=w$ and $af_1(l_j/k_j)=r^f$ [17]. By constant returns to scale, the only endogenous choice variable to the firm is l_j/k_j. Given that r^f is exogenously given, the above two conditions cannot in principle hold simultaneously unless the wage rate adjusts to a unique equilibrium level, w^E, that is consistent with profit maximization of all financially-unconstrained firms. Competitive profit maximizing equilibrium implies exactly this: If $w>w^E$, profits are negative, which cause firms to exit leading to lower demand for human capital and hence a fall of the wage rate until it reaches w^E. The opposite happens if $w<w^E$. Thus, competitive equilibrium implies that the first order conditions with regards to human capital and physical capital solve for unique equilibrium levels of the human capital/physical capital ratio, $(l_j/k_j)^E$, and wage rate, w^E.

Factor market equilibrium

Using lemma 3 we obtain the aggregate demand for human capital from financially unconstrained and constrained firms in period 1,

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[17] Note that $af_2(l_j/k_j)=w$ applies to the human capital composite used by the firm, l_j, but using the definition of $l_j=\sum_{n=0}^{\overline{n}}(1+\psi^n(h^n))l_j^n$ we have that for each of the specific labor types the condition is $af_2(l_j/k_j)((1+\psi^n(h^n))=w$. That is, given assumption (A.3) we can define the wage for workers of skill n as $w^n\equiv w/(1+\psi^n(h^n))$ for all $n=1,.....,\overline{n}$.

(2) $$L^D = \sum_{j=1}^{\tilde{U}} (l_j + l_j^M) + \sum_{c=1}^{\tilde{C}} l_c = \left[\sum_{j=1}^{\tilde{U}} k_j + \sum_{c=1}^{\tilde{C}} \chi_c \right] \phi(r^f / a) + \sum_{j=1}^{\tilde{U}} l_j^M ,$$

where $\tilde{U}$ and $\tilde{C}$ are the number of financially-unconstrained and constrained firms, respectively. Thus, we can express the economy's total demand for human capital as,

(3) $$L^D = K\phi(r^f / a) + L^M (w^E, r^f; M),$$

where $K \equiv \left[\sum_{j=1}^{\tilde{U}} k_j + \sum_{c=1}^{\tilde{C}} \chi_c \right]$ is the aggregate level of physical capital of financially-unconstrained and constrained firms in period 1 used in productive activities, and $L^M \equiv \sum_{j=1}^{\tilde{U}} l_j^M$ is the total human capital used in rent seeking activities. We note that given that the economy is assumed to be fully integrated into international capital markets, $\tilde{U}$ is variable; if the domestic profitability of physical capital increases then $\tilde{U}$ increases.

Using (1) and (3) it follows that market clearing condition for human capital implies,

(4) $$L^S (s_0^1, s_0^2, ..., s_0^{C_0}; C_0, w_0) - L^M (w^E (a, r^f / a), M) = \phi(r^f / a)K .$$

The left-hand- side of (4) denotes the total supply of human capital in period 1 as given by (1) minus the human capital employed in rent-seeking activities, and the right-hand-side is the demand for human capital for productive activities in period 1. As shown in Section 2.2, $s_0^1, s_0^2, ..., s_0^{C_0}$ and C_0 are the levels of wealth of the financially-constrained workers and the total number of constrained workers in period 0, respectively. Hence

L^s is predetermined by the investments in human capital made in the earlier periods and so is the level of total factor productivity, which depends among other things on the past availability of human capital for production (see below for more about the determinants of productivity). Also, r^f is given by international capital markets and is thus independent of the level of domestic physical capital investment. Hence, the human capital market clearing condition (4) can be attained when aggregate physical capital reaches a unique equilibrium level, K^E.[18] Equation (4) solves for $K^E = \Omega(L^S - L^M, a; r^f)$, where the function $\Omega(L^S - L^M, a; r^f)$ is increasing in L^S and a, and decreasing in r^f and L^M.

Aggregate output

Given constant returns to scale in production, firm j's production technology can be written as $y_j = af(1, l_j / k_j)k_j$. From lemma 3(ii) we have that $y_j = af(1, \phi(r^f / a))k_j$. Similarly, using lemma 3(i), the production technology of the constrained firms can be written as $y_c = af(1, \phi(r^f / a))k_c$. Thus the equilibrium aggregate output of the economy is,

(5) $$Y \equiv \sum_{j=1}^{\tilde{U}} y_j + \sum_{c=1}^{\tilde{C}} y_c = af(1, \phi(r^f / a))K^E .$$

[18] This means that the endogenous aggregate level of investment allows for the equalization of the aggregate human capital supply and demand. At $w = w^E$ the whole wage structure is determined in accordance with $w^n = (1 + \psi(h^n))w^E$ for all $n = 1, ..., \overline{n}$. At these wages equilibrium between supply and demand for each skill also occurs due to the assumption that labor skills are perfect substitutes in production. Suppose that this is not the case and that instead there is excess supply of workers of a particular skill, n. This causes w^n to become below the equilibrium one, $(1+\psi(h^n))\,w^E$, which, in turn, induces firms to instantaneously substitute among skills increasing their demand for workers with skill n until the equilibrium wage rate is reestablished. Thus, due to the perfect substitution assumption, the demand for skills is completely flexible in adjusting to the supply of skills.

Equation (5) shows that aggregate output is impervious to credit constraints affecting firms. Also, Y in (5) does not appear to be directly affected by aggregate effective human capital, $L^S - L^M$, which may seem paradoxical. However, given $\phi(r^f / a)$ there is a fixed relationship between K^E and $(L^S - L^M)$ (by (4) $(L^S - L^M)/K^E = \phi(r^f / a)$). Hence, K^E adapts to the existing supply of the effective human capital, $(L^S - L^M)$, so that $(L^S - L^M)/K^E$ ratio is set equal to ϕ. Thus, we could equivalently write (5) in terms of $(L^S - L^M)$ instead of K^E. K^E can thus be regarded as an index for all the factors used in production. The following lemma and its policy corollary summarize the most important results of this section.

Lemma 4. *(i) Credit market imperfections affecting domestic firms are of no consequence for the level of aggregate physical capital used in production.* Aggregate *physical capital is neither affected by the number of financially-constrained firms nor their levels of investment and it is instead determined by conditions prevailing in the human capital market as depicted by Equation (4).(ii) Credit market imperfections affecting firms are of no consequence for the level of aggregate output of the economy.*

Proof: As defined earlier in the text, the aggregate physical capital used in productive activities is $K \equiv \left[\sum_{j=1}^{\tilde{U}} k_j + \sum_{c=1}^{\tilde{C}} \chi_c \right]$. Suppose that financial constraints tighten so that the minimum wealth level to access credit markets increase causing $\tilde{C}$ to increase and $\tilde{U}$ to fall concomitantly (firms that were financially-unconstrained become constrained). The effect of this is to temporarily reduce the aggregate productive physical capital making $K < K^E$ thus reducing the demand for human capital. Consequently according to

(4) a temporary excess supply of human capital emerges, which causes an incipient reduction of the wage rate which, in turn, renders physical capital temporarily more profitable thus inducing firms to enter the economy. That is, $\tilde{U}$ increases until the disequilibrium in the human capital market is completely erased at $K = K^E$. Hence the new equilibrium is different from the previous one only in the composition of firms, a higher number of financially-constrained firms each investing less and a larger number of unconstrained firms that exactly compensate for the fall in physical capital among constrained firms. This shows part (i). Part (ii) follows directly from equation (5). ⊗

Corollary 4.1. *Subsidies to firms do not increase the economy's aggregate productive physical capital, aggregate output and the rate of growth of total factor productivity as long as the market borrowing interest rate (r^f) remains unchanged and continues to dictate the marginal cost of capital.*

2.4 Productivity growth, human capital and rent seeking

The solution to the equations (4) and (5) should be interpreted as a temporary equilibrium that depends on the total factor productivity, a.We now turn to the dynamics of productivity. The aggregate stock of human capital determines the size of the pool of workers with the sufficient cognitive skills necessary to create new ideas (Acemoglu, 1996). Furthermore, the diversion of human capital from productive activities to unproductive rent-seeking activities reduces the pool of human capital engaged in the generation of new productive ideas, and therefore has a negative effect on the growth of productivity (Murphy et. al., 1991) [19].

The creation and adaptation of new ideas requires that a large number of workers be able to continuously participate and interact among each other in such intent *(*Acemoglu, 1996*).* Human capital devoted to productive activities causes spillovers or externalities that promote total factor productivity, that is, productivity is increasing in $L^S - L^M$. Productivity growth, however, is subject to a maximum growth rate, $\overline{\Delta}$, which is given by the existing rate of expansion of the world technology-scientific frontier. We can then write total factor productivity function in period t as,

$$a_t = \begin{cases} a_{t-1} + \Delta(L_t^S - L_t^M) & \textit{if } \Delta(L_t^S - L_t^M) < \overline{\Delta} \\ a_{t-1} + \overline{\Delta} & \textit{if } \Delta(L_t^S - L_t^M) \geq \overline{\Delta} \end{cases}$$

Where we assume that Δ is an increasing and strictly concave function of $L_t^S - L_t^M$, and $L_t^S - L_t^M > 0 \leftrightarrow \Delta(L_t^S - L_t^M) > 0$.

Even if $(L^s - L^M)$ is fixed there will exist a constant flow of productive new ideas, which may allow for the increase of the total factor productivity of the economy over time as long as the economy's productivity growth is below the maximum technology frontier. For economies where productivity is already growing at the technology frontier growth rate, productivity growth rate may not be increased by further investment in human capital. That is, the rate of productivity growth is non-

[19] Lobbying attracts significant resources in the United States. In a summary of various literatures on lobbying, McGrath (2006) reports that the Washington component of lobbying-connected activities employs at least 100,000 people, most of them highly educated (Nownes, 2006). A survey of Oregon lobbyists by Berg (2009) found that 90% had a bachelor's degree with 51.8% having an advanced degree.

increasing in productive human capital for $L_t^S - L_t^M \geq \Delta^{-1}(\overline{\Delta})$. Presumably, there is no country or only very few of them that fully exploit the technology frontier as a source of productivity growth. This means that the majority of the countries, especially those that face the most unabated human capital market imperfections, may not exploit the full potential of the technological frontier growth. Hence, at least for the vast majority of the countries we can assume that total factor productivity growth is increasing in their respective stocks of human capital used in production. Thus, a productivity growth function in continuous form can be written as,

$$\dot{a} / a = g^a(L^S - L^M; Z^a), \quad (6)$$

where Z^a denotes other factors that may affect productivity growth and the function g^a is increasing in $L^S - L^M$ (we henceforth omit time subscripts).

The following lemma summarizes these ideas.

Lemma 5. *(i) Credit rationing affecting households and rent-seeking activities reduce the stock of human capital engaged in creating productive new ideas. (ii) For countries exhibiting productivity growth rate below the world technological frontier one,* $\overline{\Delta}$*, the rate of productivity growth is increasing in productive human capital and, hence, unmitigated credit rationing affecting households as well as rent seeking reduce the rate of growth of total factor productivity.* ⊗

2.5 Implications for government subsidy policies

The following two propositions summarize the key implications of the lemmas 1 to 5 for fiscal policies:

Proposition 1. *In economies affected by credit-rationing, subsidies to households or workers increase the aggregate supply of human capital and enhance the human creativity pool, which in turn, may cause a faster rate of productivity growth, and also more investment in physical capital. All this leads to a faster rate of economic growth.*

Proposition 2. *Subsidies to firms (with the possible exception of R&D subsidies) do not increase aggregate investment in physical capital, cause little spillovers into the household sector to relieve its financial constraints, and by contributing to divert more of the scarce stock of human capital to rent-seeking activities, reduce the rate of growth of total factor productivity and hence economic growth.*

2.6 Towards an empirical specification of the model

To link the theoretical model with an empirically estimable one we need to assume a functional form for the production function. A common practice in growth models has been to assume a Cobb-Douglas production function. However, modern empirical studies have consistently rejected the assumption of a unitary elasticity of substitution implied by the Cobb-Douglas function and instead have shown that the elasticity of substitution between physical capital and human capital is far lower than 1 (Pessoa et.al., 2005; Antras, 2004; Jalava, 2006; Claro, 2003). We thus assume a CES production function with a less-than-one elasticity of substitution ($\sigma < 1$). Denote the growth rate of per capita output as g^y, the growth rate of productivity as g^a, and the rate of growth of productive human capital as $g^{L^S - L^M}$. Also define g^{r^f}, g^k, g^{s_0}, g^C, g^{L^M} as the growth rates for the market interest rate, physical capital per capita, the wealth of the financially-constrained workers, the number of financially-constrained workers, and human capital devoted to rent-seeking activities, respectively. Also define $\varpi \equiv \frac{(\alpha a / r^f)^{1-\sigma}}{(\alpha a / r^f)^{1-\sigma} - \alpha} > 1$. Lemma 6 constitutes the crucial bridge between the theoretical and empirical models:

Lemma 6. *With the assumption of a CES production with an elasticity of substitution less than one, we obtain a system of output growth (7) and physical capital growth (8) equations,*

(7) $$g^y = (1-\sigma)g^a + g^k + \sigma g^{r^f}$$

(8) $$g^k = g^{L^S - L^M} + \sigma\varpi(g^a - g^{r^f}).$$

Proof. *See Appendix I.*

The growth version of the left-hand-side of Equation (4), that is the growth rate of productive human capital, can be approximated as,

(9) $$g^{L^S - L^M} = \lambda_1 g^{s_0} - \lambda_2 g^C - \lambda_3 g^{L^M}$$

where λ_1, λ_2, and λ_3 are positive parameters and the rest of the variables are defined in the text above. Finally, using a linear approximation for the equation of total factor productivity (equation (6)),

(10) $$g^a = \gamma_1 \left[L^S(s_0^1, s_0^2, ..., s_0^C; C_0, w_0) - L^M(w^E, r^f, M) \right] + \gamma_2 Z^a;$$

where Z^a are factors other than L^S and L^M that may affect productivity growth, γ_1 and γ_2 are positive parameters and γ_2 is a fixed parameter. Equations (7) to (10) constitute the basic link between the theoretical model and the empirical econometric model derived below.

It might seem paradoxical that in (7) the effect of increases in the interest rate, r^f, on the rate of growth may be positive. This is true for a given rate of growth of physical capital, reflecting the fact that an increase of r^f induces greater use of human capital. However, from (8) it is clear that the rate of growth of physical capital is decreasing in r^f and, moreover, using (8) in (7) we obtain the following reduced-form output growth equation,

(11) $$g^y = (1 + \sigma(\varpi - 1))g^a + g^{L^S - L^M} - \sigma(\varpi - 1)g^{r^f}$$

Thus, the net effect of g^{r^f} on economic growth is negative equal to $-\sigma(\varpi - 1)$ (remember that $\varpi > 1$). Similarly, from the above equation it is clear that the net effect of the growth of total factor productivity on economic growth is greater than 1. This is the *productivity-magnification* effect: The rate of growth of total factor productivity exerts a greater than proportional effect on economic growth.

2.7 The Hypotheses

Proposition 1 shows that total factor productivity, growth of physical and human capitals are all functions of the levels of government spending on social subsidies in period 0 (PME_0). The wealth levels of households or workers are increasing in PME_0, $\partial s_0^i / \partial PME_0 \geq 0$ (for $i = 1,....,N$ with a strict inequality for some i), and the number of financially-constrained workers is decreasing in PME_0, $\partial C_0 / \partial PME_0 < 0$. Hence, from (1) given that $L^S(s_0^1, s_0^2,......, s_0^C; C_0, w_0)$ is increasing in s_0^i and decreasing in C_0, it follows that $\partial L^S / \partial PME_0 > 0$. Moreover, Proposition 1 also predicts that the rate of growth of total factor productivity is increasing in $L^S - L^M$ and hence is increasing in the lagged level of PME, $\partial g^a / \partial PME_0 > 0$.

The (negative) effect of government subsidies to firms (*RME)* on the rate of productivity growth is due to their links the variable *M*. Expenditures in non-social subsidies are used to build the necessary institutional and financial infrastructure to establish and maintain the system of channeling and allocating the benefits. Hence we may expect that M is the result of past expenditures in *RME.* Since L^M is increasing in M (see lemma 3(iii)) and M is increasing in RME it follows that $\partial L^M / \partial RME_0 > 0$,which by Lemma 5 (and equation (6)) implies $\partial g^a / \partial RME_0 < 0$.

Thus we can write the rates of growth of total factor productivity, physical capital, human capital and the interest rate facing country i at time t as functions of the lagged spending patterns and other factors, $g_{it}^a(PME_{it-1}, RME_{it-1}; Z_{it}^a)$, $g_{it}^k(PME_{it-1}, RME_{it-1}; Z_{it}^k)$, $g_{it}^{L^S - L^M}(PME_{it-1}, RME_{it-1}; Z_{it}^L)$, and $g^{r^f}(Z_t^r)$, respectively, where $Z_{it}^a, Z_{it}^k, Z_{it}^L$ and Z_t^r are other factors that may affect the growth of productivity, physical capital, human capital, and interest rate, respectively. Using equations (8) to (11) it follows that

$$g_{it}^{y} = \sigma g_{it}^{a}(PME_{it-1}, RME_{it-1}; Z_{it}^{a}) + (1-\sigma) g^{r^f}(Z_t^r) + g_{it}^{k} \tag{12}$$

$$g_{it}^{k} = g_{it}^{L}(PME_{it-1}, RME_{it-1}; Z_{it}^{L}) + \beta[g_{it}^{a}(PME_{it-1}, RME_{it-1}; Z_{it}^{a}) - g^{r^f}(Z_t^r)] \tag{13}$$

where $\beta = \varpi\sigma > 0$. Propositions 1 and 2 lead to the following testable hypotheses:

The Central Hypotheses: *The functions* g_{it}^{a}, g_{it}^{k} *and* g_{it}^{L} *are increasing in* PME_{it-1} *and decreasing in* RME_{it-1}. *Given (12) and (13) it follows that: (1) a reallocation of government spending from RME to PME promotes faster economic growth.* (2) *RME may reduce* g_{it}^{a}, g_{it}^{L}, or even g_{it}^{k} *and hence slowdown the rate of growth of the economy.*

3. Empirical Strategy

We derive a reduced-form equation for per capita GDP growth from the key theoretical equation (7). We first estimate this model using panel country level data focusing mainly on the government variables, using highly parsimonious and eclectic specifications, which rely on fixed and country-specific time-varying coefficients to account for the other potential factors that may affect economic growth. We then sequentially expand the set of controls a great deal to ascertain the robustness of the estimates.

The approach is directed to at least partially mitigate some of the most serious objections to cross country panel analyses raised in the literature. Durlauf et. al. (2005) has summarized these objections: (1) model uncertainty, which introduces significant ambiguity about the empirical specification, specifically the control variables included. This issue is particularly serious to the extent that the estimates of the parameters of interest may be affected by changes in the control variables used. (2) Parameter heterogeneity caused by the fact that cross country regressions often use data from countries that are at very different stages of development, which may have different production functions. (3) Biased estimates due to reverse causality and the omission of variables that may be correlated with the statistical error term.

To deal with (1) we use two approaches: A model that allows us to control for an unspecified number of factors relying on fixed and time-varying country-specific effects, which we call Variable Country Effects (TVC) method. In addition, we expand the empirical specification to sequentially introduce a large number of measured control sets using a procedure first proposed by Altonji (2005). We consider (2) by using several sub-samples comprising of countries that are at similar stages of development to see whether the narrowing of the samples in several directions cause the basic results of interest to change. With respect to (3), we use a lagged structure of the explanatory variables that is in fact predicted by the theoretical model, which in the context of the TVC method should greatly reduce the risks of inconsistent estimates associated with the combination of reverse causality and omitted variables.

3.1. Estimating Model

To estimate the output growth equation (12) we normalize the variables of interest as follows: PME_{it-1} is divided by total government expenditures, defining $pme_{it-1} \equiv PME_{it-1} / G_{it-1}$; instead of using RME_{it-1} as a separate variable we use total government spending (excluding public investment) normalized by GDP using the variable $q_{it-1} \equiv G_{it-1} / GDP_{it-1}$. Also we follow the common practice of approximating physical capital growth by total investments (including private and public) in physical capital normalized by GDP using the variable $inv_{it} \equiv INV_{it} / GDP_{it}$. These are merely convenient normalizations that permit a more precise estimation and allows for a direct assessment of the government spending composition effect. Furthermore, these normalizations make the newly defined variables unit free thus mitigating measurement problems originated in currency fluctuations and inflation across countries and over time. Finally, we proxy the (largely unknown) control variables Z_{it}^{a} with country-idiosyncratic fixed and time-varying effects while we use common-to-all-country time effects in lieu of Z_{t}^{r} in (12)

Using the above normalizations we can write the rate of growth of per capita GDP from (12) as,

(14) $$g_{it}^{y} = \eta_1 pme_{it-1} + \eta_2 q_{it-1} + \eta_3 inv_{it} + \nu_{it} + \tau_t + \mu_{it}$$

where ν_{it} is a function that encapsulates the country-specific fixed and time-varying effects and τ_t are the common-to-all-countries time effects. μ_{it} is the stochastic disturbance assumed to be independent and identically distributed with a zero mean and fixed variance; η_1, η_2 and η_3 are fixed parameters. Since we use inv_{it} instead of growth of per capita physical capital, η_3 is not equal to 1 as suggested by equation (7). Since $g^k = inv(GDP/K) - \delta$ (where δ=rate of physical capital depreciation) it follows that $\eta_3 \approx (GDP/K)^A$, where $(GDP/K)^A$ is the average GDP/K ratio in the sample. Since the physical capital stock values are typically much larger than annual levels of GDP (Hamilton, 2005), it is expected that η_3<1.

The use of fixed and time-varying country-specific effects in lieu of the vectors Z_t^r and Z_{it}^a, respectively is recognition of our ignorance about the many other factors that are likely to affect international capital markets and domestic productivity growth. This is a drastic departure from the standard approach where authors often guess what such factors may be on the basis of specific conceptual models as well as on the availability of data. However, we do check the robustness of our results by combining this approach by adding a large number of specific control sets.

We need to specify the nature of the country-idiosyncratic time-varying effect function, v_{it}. The TVC approach assumes that v_{it} is a function, which can be approximated by a (T-2)th order (country specific) polynomial function of time where its parameters are allowed to take different values for each country. Typically potential important control variables, for example microeconomic policies, political institutions, property rights and so forth, follow certain patterns, which tend to change over time non-linearly, not always monotonically, and in a country-idiosyncratic manner, but their changes may exhibit some degree of systematic correlation with time. Thus, such omitted control variables may be adequately captured by polynomial functions of time that are sufficiently flexible. We postulate the following polynomial function,

(15) $$\nu_{it} = b_{0i} + b_{1i}(trnd) + b_{2i}(trnd)^2 + b_{3i}(trnd)^3 + ... + b_{T-2i}(trnd)^{T-2} + e_{it}$$

Where $b_{0i}, b_{1i}, b_{2i}, b_{3i}, ...b_{T-2,i}$ are fixed coefficients that are allowed to be different for each country, and *trnd* is a time trend variable. The coefficients b_{0i} correspond to the fixed country effects and the remaining coefficients capture the country-idiosyncratic time-varying effects.

Substituting (15) into (14) we obtain the estimating equation with new disturbance term $\tilde{\mu}_{it} = \mu_{it} + e_{it}$. We assume the polynomial in equation (15) is an exact approximation of ν_{it}, and thus the residual of the polynomial approximation, e_{it}, is assumed to be random and independent of time, an assumption that is empirically tested. If this assumption is not rejected then the TVC model would be able to control for unobserved time-varying country-specific variables thus mitigating possible biases to the coefficients of interest that would arise if the unknown control variables are correlated with the explanatory variables considered, a perennial problem of cross country analyses (Acemoglu et. al. 2001; Bose et. al. 2007).[20]

One could fully control for the time-varying country-specific effects (i.e., all the ν_{it} effects) by using the complete matrix of country-year dummies but of course this would leave no degrees of freedom to estimate the effect of any other variable. It is easy to see that estimating a $(T-1)^{th}$ order polynomial function of time for each country

[20] One concern might be that the TVC imposes a continuous rather than discrete control for time-varying effects. However, while the use of dummy variables in the standard approach to control for fixed country effects can be regarded as a discrete approximation, the effect of the effects of observed variables are indeed assumed to be continuous in most standard analyses. So the assumption of continuous unobserved effects is a natural extension of the standard regression analysis. Moreover, as we show below the TVC yields the discrete fixed effect model as a special case.

would be equivalent to estimating the complete matrix of country-year dummies. However, if we assume that the unobserved effects are not completely time-anarchic, a (T-2)th polynomial may be sufficiently flexible to capture these patterns while still permitting the estimation of the effects of observed variables. Thus, if e_{it} and hence $\tilde{\mu}_{it}$, is time independent, then the (T-2)th polynomial estimation may be sufficient to uncover the effects of the omitted variables and thus mitigate time-varying country-idiosyncratic omitted variable biases.

The TVC is a generalization of the standard fixed country effects model (FE) so often used in growth regressions (for example, Fölster and Henrekson, 2001, and Afonso and Furceri, 2010). The fixed country effects correspond to the b_{0i} coefficients in (15) and thus FE can be regarded as a special case of TVC where (15) is restricted by imposing that all coefficients other than the country constants be zero. Since the FE model is nested in the TVC model we can test the validity of the FE model parametrically by imposing the following restrictions: $b_{1i} = b_{2i} = ... = b_{T-2i} = 0$ for all $i \in \{1, 2, ..., I\}$.[21]

Investment in physical capital

Given that in the growth equation we control for the level of investment, to get the full effect of the government spending variables we need to also estimate an investment equation. We use equation (13) arising from the theoretical model to postulate the

[21] Similarly the Random Effects (RE) specification could also be tested if we allow for a random instead of deterministic intercept to the v_{it} function.

following investment equation using the same normalizations for the government spending variables as those used in the per capita GDP growth equation,

$$inv_{it} = \Gamma_1 pme_{it-1} + \Gamma_2 q_{it-1} + \Gamma_3 g^{y}_{it-1} + \tilde{\tau}_t + \tilde{v}_{it} + \varepsilon_{it} \tag{16}$$

where $\Gamma_1, \Gamma_2, \Gamma_3$ are fixed parameters. Consistent with the theoretical analysis, investment is determined by the lagged government spending variables. In addition we postulate that investments are also determined by past rate of economic growth (Garcia-Belenger and Santos, 2011). We use the same strategy to control for other unspecified factors using country-idiosyncratic time-varying functions ($\tilde{v}_{it}$) also specified as polynomial functions of time as in (15), as well as common-to-all-countries time effects ($\tilde{\tau}$).

To gain efficiency we estimate the investment and growth equations jointly using a Seemingly Unrelated (SUR) estimator. We thus compute the direct or productivity effect and the indirect or investment effect of *PME* and *RME* on economic growth.

Further remarks about the empirical specification

The fact that we use lagged values for the two government spending variables is theoretically justified and also presents some advantages for the estimation by mitigating potential biases due to reverse causality. But of course if omitted variables are correlated with the lagged government expenditure variables the coefficient estimates may still be inconsistent. However, the fact that the TVC specification controls for time-varying omitted variables, implies that it may mitigate the potential inconsistencies of the estimated coefficients of interest.

A pertinent issue is government spending efficiency. In this study we focus on efficiency of government spending associated with its allocation of expenditures – the effects of a reallocation from RME to PME spending is hypothesized to increase government spending efficiency. The direct independent efficiency of each spending category (PME or RME) is an issue, which we do not address here; we assume that both types of spending are equally inefficient. This assumption is partially justified by the fact that a priori there are no obvious reasons to presume that spending efficiency of each category may be different.

Testing the predictions from the theoretical model

The hypotheses postulated by the theoretical model are valid if the coefficient of the share of PME in total expenditures, η_1 in (14), is positive and statistically significant and if the coefficient of the share of total government spending on GDP, η_2 in (14), is non positive. If these conditions are met then we can conclude that the effects of PME through total factor productivity is positive while the effect of RME is negative as predicted by the theoretical analysis. In addition, the theoretical model predicts that $0 < \eta_3 < 1$. These are the direct effects controlling for physical capital investments.

The theoretical analysis also predicts that the rate of growth of physical capital represented by the investment/GDP ratio, is positively affected by PME due to its positive effect on total factor productivity, which in turn increases the rate of return to physical capital. *RME* is predicted to exert a negative effect on investment in physical capital because *RME* induces a diversion of human capital from productive activities. Less human capital in production lowers the marginal product of physical capital and hence reduces investment. Thus, the theoretical analysis predicts that $\Gamma_1 > 0$ and $\Gamma_2 \leq 0$ in (16). Therefore, using the estimated parameters η_1, η_2, η_3, Γ_1, and Γ_2 we can test the predictions of the theoretical model and compute the net growth effects of *PME* and *RME*.

To gain more precise empirical insights on the central hypothesis regarding the effects of government social subsidies as a factor mitigating the negative effects of human capital market failure on growth, we disaggregate government spending further by considering social spending as a separate category. From the theoretical model one expects that the mechanism by which *PME* may contribute to increase economic growth is through the effect of social expenditures on human capital and, consequently, total factor productivity growth. Other public goods spending contained in the *PME* category (most prominently infrastructure) may affect economic growth mainly through its effect on aggregate investments.

We use an unbalanced 5-year panel from 1980 to 2009 for 29 developed and 66 developing countries (country list is at the bottom of Table A1). We choose to use 5-year averages for each country because the effect of the composition of government expenditures on economic growth is not likely to be instantaneous and we consider that five years is sufficient time to allow most of the effects of government spending to manifest themselves in patterns of growth.

3.2 Data

The lagged share of government expenditure on *PME*, is obtained from the Government Financial Statistics (GFS) complemented with national data sources. GFS data is widely used in the literature (Shelton 2007). *PME* include expenditures on health, education, housing, social protection, culture, environmental protection, and public order and safety. *RME* expenditures include all subsidies to firms (apart from R&D and environmental protection subsidies), agricultural subsidies, credit subsidies to firms and other non-social subsidies. Table A1 provides the data sources and definitions.

Table A2 shows the summary statistics of the variables used in the regressions. The median of the share of *PME* spending in the sample is 54.3% of total government spending with a standard deviation of 15.3. Table A3 presents composition of *PME* and *RME* spending as well as trends over time. About 82% of *PME* expenditure corresponds to social subsidies in the form of education, health care and social security. In general, there is a steady increase in *PME* spending over the sample period, mostly due to increases in social subsidies. *RME* expenditures account for about 44% of government expenditures and have declined over time in most countries.

3.3 Results

3.3.1 Single Equation Estimators of growth

Table 1 presents the results for the various empirical methods considered in the previous section using the single equation specification for the rate of per capita GDP growth. Columns 2 and 3 in Table 1 show the estimates of the restricted versions of the model (14) using standard Two-Way Fixed (TWFE) and Two-Way Random effects (TWRE) (in column 1 we present the OLS estimates for comparison purposes). The robust standard errors of the coefficients are reported in brackets. [22] Columns 4 and 5 in Table 1 present the TVC-FE estimates as specified in Equation (14) and (15) using a second and third order approximations for the functions v_{it}, respectively.[23] The TVC-FE method imply estimating up to 4 additional coefficients for each country that should control for fixed country effects as well as for time-varying effects all of which are allowed to be different for each country.[24]

[22] Stock and Watson (2008) suggest that robust standard errors may be preferable to clustered standard errors under fixed-effects estimation when the number of countries is large and the number of observations per country is short as in our case.

[23] Most of the countries in the sample have 5 or less observations which limits the approximation of the v_{it} functions to a third order as a maximum; that is, we estimate 4 coefficients for each country to approximate the v_{it} function, a country-specific constant plus 3 coefficients associated with time up to the cubic level. For countries with 4, 3 and 2 observations we allow for second, first and a fixed country effect, respectively. There are a few countries that have 6 observations which may allow us to use a fourth order approximation for them. We provide the results with a 4^{th} order approximations for these countries in tables B4 and B5 in the online Appendix: http://www.arec.umd.edu/People/Faculty/Lopez_Ramon/OnlineAppendix.pdf.

[24] Table B4 in the Online Appendix (http://www.arec.umd.edu/People/Faculty/Lopez_Ramon/OnlineAppendix.pdf) shows the results obtained using TVC-RE method, which assumes that the constant terms in the v_{it} functions are random instead of deterministic.

The various models provide remarkably similar qualitative estimates for the effects of pme_{it-1} and q_{it-1} on the growth equation. All models show that lagged share of government expenditure on *PME* yields a positive and statistically significant coefficient at least at 5% level of significance. In addition, all estimates yield statistically insignificant coefficients for the effect of total government expenditure variable. The estimates for the effects of investment are positive and significant. These estimates suggest that a reallocation of government spending from *RME* to *PME* expenditures results in a faster rate of per capita GDP growth while the effect of total government expenditures is insignificant. It may be that the increase in total government coupled with a rise in taxes is what renders the effect of total government insignificant. Therefore, as a robustness check, we included the share of taxes over GDP as an additional control. Both total government and total taxes over GDP remained statistically insignificant. The findings that total government expenditures have non-positive effects on growth and the share of PME spending has a positive and significant effect on growth, yields a negative and significant effect of RME on growth.

Specification tests

We first test whether the residuals of the estimations are in fact time independent as is required for the TVC-FE to be a valid approach. Table 1 reports p-values of the test, which shows that time trend variable for the estimation $\tilde{\mu}_{it} = constant + \beta(trnd)$ is statistically insignificant. This is consistent with the assumption that the $\tilde{\mu}_{it}$ error component is uncorrelated with time, which suggests that the third order polynomial function of time used is a good approximation for the time-varying country-idiosyncratic effects. Next we test for the validity of the standard TWFE estimators by testing the null hypothesis $b_{1i} = b_{2i} = b_{3i} = 0$ for all *i*, using a maximum likelihood ratio test. As shown in Table 1, the restricted model is rejected by a broad margin meaning that the TVC-FE model should be preferred over standard TWFE model.

We also conducted further analysis on the time-varying country specific effects. The estimated predicted value of the v_{it} function is positive for 49 countries, which implies that the unobserved variables tend to improve per capita GDP growth. The predicted values of v_{it} are time monotonic for 33 countries. For 23 countries the growth effect of the time-varying effects has just one turning point over time, while for 16 countries have two turning points (Table B1, online Appendix: http://www.arec.umd.edu/People/Faculty/Lopez_Ramon/OnlineAppendix.pdf).

3.3.2 TVC-FE-SUR approach: estimating the growth and investment equations jointly

The single equation estimation reported above yields a partial effect on growth because we are controlling for investment. The fact that the effect of investment on growth is positive and significant (under most estimates) means that it is possible that *RME* may increase investments and that this investment effect may dominate over the negative direct effect of *RME* on economic growth. Below we report the results of the joint estimation of the growth equation and investment equations. This serves a dual role: first it provides insights about the investment effects allowing us to compute the total net effects of *PME* and *RME* on growth considering both their direct or productivity impact and indirect effect via investment. Second, it serves as a robustness test to the estimates obtained using single-equation methods.

Table 2 reports the results of the *TVC-FE-SUR* estimation of the growth and investment equations. These results fully corroborate the finding for growth using the single equation approach just reported. In fact, the effects of the two government spending variables on the per capita GDP growth rate are similar to the effects obtained using single equation specification. Also, the coefficient of the pme_{it-1} variable on investment is positive and statistically significant but the coefficient of the q_{it-1} variable is insignificant. These two results combined imply that the net effect of *PME* on investment is positive and significant while the effect of *RME* is negative and significant.

Further disaggregating government spending

Table 3 presents the results of the *TVC-FE-SUR* estimation using further disaggregated spending components. *PME* spending is split into social subsidies and non-social public goods, and we also include *RME* spending specific to economic affairs (excluding transport and communication) in the specification. Economic affairs include mostly agricultural, forestry, fishing, mining, manufacturing, construction, fuel and energy subsidies. The omitted spending category is other *RME* spending, which mostly consists of national defense spending. Consistent with the predictions from the theoretical model, the results indicate that social subsidies mainly account for the positive direct (controlling for investments) effects of *PME* spending on economic growth. Non-social public goods (comprised mostly of infrastructure spending) have an insignificant direct effect on growth, although their effect on investment is positive and significant. With respect to *RME* spending, it has a negative effect on economic growth when using second order approximation for the function ν_{it}. However, this significance is lost when we use third order approximation.

The estimates generally are consistent with the theoretical prediction that spending on social goods partially mitigates households' credit constraints thus allowing for faster human capital accumulation. This raises the rate of economic growth to the extent that the enhanced human capital contributes to accelerate the rate of total factor productivity, which, in turn, causes greater returns to investment and hence higher investment levels. The estimates in Table 3 fully support this interpretation; the estimated effects of social public goods (reported in the first row of the Table) on both economic growth and investment are positive and highly significant in all cases considered. Also, the positive and significant effect of non-social public goods on total investment is plausible given that infrastructure spending is a significant component of non-social public good spending and thus likely to complement private investment. As shown in Table 3, the estimated effects of public infrastructure are much greater than the participation of government investment in total investment, which suggests that a large portion of the effect of increasing government spending in infrastructure on total investment may be attributed to its effect on private investment.[25]

3.3.3 Potential dynamic effects: GMM approach

So far we have assumed that economic growth is not affected by inertia, which could require using a dynamic panel approach. We thus use the Arellano-Bond two-step procedure "System" Generalized Method of Moments (GMM); results are shown in Table A4. We used both collapsed and un-collapsed instruments[26]. The GMM procedure mitigates potential reverse causality biases of the explanatory variables that may exist in the determination of GDP per capita growth. One variable of concern is investment over GDP, which is not lagged in the empirical specification. However the GMM estimate in Table A4 for the effect of Investment over GDP is positive and highly significant and only moderately lower than the estimates in Table 2. The estimates for the pme_{it-1} variable are positive and significant at 1% while the coefficient of the q_{it-1} variable remains statistically insignificant. Finally, the lagged

[25] Aggregate investments include public investment in infrastructure which in the sample accounts for about 8% of total GDP on average. In Table 3 the estimated elasticity of the effect of public investment on total investment is about 0.196 when the third order approximation for v_{it} is used. This effect is thus more than double the participation of public investment on GDP.

[26] Collapsing the instruments imply creating one instrument for each variable and lag distance, rather than one instrument for each time period, variable, and lag distance (Roodman, 2006)

dependent variable is not statistically significant suggesting that the approaches reported in Tables 1 and 2 that ignore dynamic effects are correct.[27] Thus the GMM estimators are highly consistent with the single-equation and SUR estimates reported earlier.

3.3.4 Robustness Analyses

While the main results are robust to the methods of estimation the actual specifications used may be considered excessively parsimonious by failing to explicitly control for other variables that could affect the results. We address this issue by using a battery of robustness checks described below.

Added Controls Approach

Several studies have emphasized that governance and institutions (Rodrik et. al, 2004; Milesi-Ferretti et al, 2002), human capital and income distribution (Esteban and Ray, 2006; Alesina and Rodrik, 1994; Persson and Tabellini, 1994), and demographics and geography (Sachs et al., 1999), are potential important determinants of economic growth. We sequentially introduce one set of variables representing each of the determinants listed above in the TWFE and TWRE base models estimations. Table 4 shows how the effect of pme_{it-1} on per capita GDP growth rate changes with different sets of control variables. A set of added control variables raises the explanatory power of the estimation if the adjusted R-squared increases relative to the base level. Adding

[27] The Hansen test indicates that the over-identifying restrictions are not rejected and thus instruments as a group are exogenous. The AR(2) test indicates there is no further serial correlation at all levels of significance for un-collapsed instruments and collapsed instruments.

variables representing demography increase the explanatory power of the TWFE estimates with respect to the basic model. For all sets of controls, the explanatory power of the TWRE estimates increase. The sign and significance of the coefficient of the pme_{it-1} variable is unaffected no matter what set of variables are included. Moreover, the lack of significance of the q_{it-1} variable on per capita GDP growth rate (not reported in the Table) also remains.

Country Heterogeneity

Despite that the use of TVC-FE estimators appears to control well for time-varying and fixed country heterogeneity we conducted a simple test to confirm this. We ranked all the countries in the sample according to average GDP per capita over the sample period. We then dropped the top and bottom countries, and re-estimated the coefficients. We started by dropping one country at each end and then two countries at each end and so forth until we dropped 30 countries at each end ending with a "homogenous" sample of just 23 middle income countries. The idea is to verify whether the coefficients sign and significance change as the degree of country heterogeneity gradually decreases. The coefficient of the pme_{it-1} variable remains positive and statistically significant throughout the full process. Similarly, the coefficient of the q_{it-1} variable remains statistically insignificant in almost all cases. In addition, the estimates obtained using only the top half of the sample and developing countries only also remain qualitatively identical.[28]

[28] Further sensitivity tests are available in the Online Appendix (http://www.arec.umd.edu/People/Faculty/Lopez_ Ramon/OnlineAppendix.pdf): We omitted from the sample observations for the top and bottom 5% values of share of PME expenditure, and the estimates

3.3.5 Quantitative importance of the effects of PME and RME on growth

Increasing the share of *PME* in total government spending has two effects on the rate of economic growth, a direct one shown in column 3 of Table 2, which reflects mostly the effect of *PME* on productivity growth for a given level of investment and an indirect one through its effect on investment as shown in column 4 of table 2. According to the estimates using the two-equation SUR reported in the last two columns of Table 2, the direct or productivity effect of increasing the share of PME in total government spending by one standard deviation of the sample (an increase from the observed average of 54% of total spending to 69%) increases the annual per capita GDP growth rate by 0.83 percentage points when evaluated at the mean sample values. Additionally, the above increase of PME induces a rise in the rate of investment of about 0.67 percentage points that in turn is translated into a further increase of the per capita GDP growth of the order of 0.05 percentage points. Thus, the total effect of a one standard deviation increase of PME considering its productivity and investment effects is to expand the rate of per capita GDP growth by about 0.9 percentage points. The total effect is statistically significant at 1% level of significance.

To assess the importance of this effect consider that the average annual per capita GDP growth rate for the whole sample is 1.9%. Thus, increasing the participation of *PME* in total government spending by one standard deviation would raise the annual rate of per capita GDP growth from 1.9% to 2.8%. The 0.9 percentage

were still significant for all estimating models. We also tested for country dominance by dropping one country at a time. The signs and significance for the share of PME spending remain positive and significant.

point increase on the growth rate that the rise of *PME* induces is equivalent to almost one third of the standard deviation of per capita GDP growth over the sample.

The insignificance of the effects of total government spending on both per capita GDP growth and investment rate implies that the effects of *RME* on growth and investment are practically equal to the effect of *PME* but with an opposite sign. That is, *RME* expenditures exert a negative and significant effect on economic growth. Raising *RME* by 15 percentage points induces the annual per capita GDP growth rate to fall by about 0.9 percentage points. Thus, the results show that while increasing social subsidies and public goods promote faster economic growth, spending on non-social subsidies is toxic for economic growth.

4. Conclusion

This paper has shown that switching fiscal expenditures from non-social subsidies to social subsidies and public goods, keeping total government spending constant, promotes faster economic growth. Keeping the composition of government spending constant, increasing total government spending does not promote growth or investment. Increased total government spending entails increasing both social and public goods as well as non-social subsidies by the same proportion. This means that the positive growth effects of social and public goods spending are likely offset by the toxic effect of non-social government spending.

In addition, we have shown that within *PME*, the most important effect on economic growth and on investment is associated with social government expenditures, thus supporting our key hypothesis, that social expenditures by partially mitigating credit market failures affecting households' investment in human capital, induce a faster rate of total factor productivity growth, which in turn, is translated in a permanent raise of the rate of economic growth. These findings are important because most countries spend a large fraction (40% on average in our sample) on private subsidies.

The basic results passed broad and rigorous sensitivity tests with great consistency. Moreover, the analysis suggests that the quantitative effects are large. The average country may increase its growth rate by almost 50% if it raises its share of social and public good expenditures by about 30%. This is a large effect that could, after a few decades, make the difference between development and underdevelopment.

Should this large impact be astonishing? Given that governments spend more than one third of national income, a misallocation of part of such expenditures can be expected to have large consequences. Wasting 10% or more of the total output produced by the economy is a serious issue. Using such an enormous amount of resources in subsidies that are at best ineffective and at worst toxic for growth instead of allocating them to enhance the potential for creativity of individuals, in health care and better infrastructure is likely to be highly deleterious for economic growth.

The findings in this paper provide an encouraging message. Economic crises, which have often given governments an opportunity to correct fiscal spending misallocation built up during "normal" times may have a positive dividend for countries that use the opportunity to restructure fiscal spending towards social goods that are more consistent with a faster rate of economic growth over the medium run. This is consistent with casual evidence that some countries that emerge from deep crises are often able to grow faster than in periods before them.

Table 1: Government Spending and per capita GDP Growth – Single Equation Estimators

	OLS	Two-Way Fixed Country Effects (TWFE)	Two-Way Random Country Effects (TWRE)	Variable Country Effects (TVC-FE) with 2nd order approximation of v_{it}	Variable Country Effects (TVC-FE) with 3rd order approximation of v_{it}
Share of government PME in total government Expenditures (lagged)	0.048***	0.084***	0.056***	0.115**	0.112**
	[0.009]	[0.019]	[0.011]	[0.046]	[0.052]
Total government consumption expenditures over GDP (lagged)	-0.04	0.041	-0.038	-0.115	-0.076
	[0.032]	[0.105]	[0.041]	[0.211]	[0.193]
Total investment over GDP	0.067***	0.083**	0.069***	0.186***	0.134*
	[0.020]	[0.033]	[0.023]	[0.070]	[0.079]
Log of initial per capita GDP	0.004		0.005		
	[0.017]		[0.021]		
Federal dummy	-0.008**		-0.008*		
	[0.003]		[0.004]		
Country dummies x time trend	No	No	No	Yes	Yes
Country dummies x (time trend)^2	No	No	No	Yes	Yes
Country dummies x (time trend)^3	No	No	No	No	Yes
Adjusted R^2	0.25	0.41	0.25	0.47	0.53
Number of observations	370	370	370	358	358
Number of countries	95	95	95	83	83
Specification Tests					
Test for the time independence of the residuals: p-values				0.9977	0.1783
Correlation coefficient between the residuals and time trend				-0.0002	0.0713
Test for fixed country effect model Ho: $b_{1i} = b_{2i} = b_{3i} = 0, \ \textit{for all } i$ Log Likelihood Ratio Test				295***	469***

Significant at *10%; ** 5%; *** 1%, Unit of observation: 5 year averages. Robust standard errors in brackets; All estimates include time period dummies common to all countries. OLS and RE estimates include region dummies for Latin America, East Asia, and Developed. TVC estimates include 212 and 254 country specific coefficients in column 4 and 5, respectively to capture the v_{it} effects.

Table 2: Government Spending and per capita GDP Growth – System Estimators

	TVC-FE-SUR with 2nd order approximation of v_{it} and $\tilde{v}_{it}$		TVC-FE-SUR with 3rd order approximation of v_{it} and $\tilde{v}_{it}$	
Dependent Variable	GDP per Capita Growth	Investment over GDP	GDP per Capita Growth	Investment over GDP
Share of government PME in total government Expenditures (lagged)	0.119*** [0.025]	0.148*** [0.034]	0.112*** [0.025]	0.095*** [0.035]
Total government consumption expenditures over GDP (lagged)	-0.09 [0.078]	0.027 [0.106]	-0.056 [0.068]	0.084 [0.096]
Total investment over GDP	0.124*** [0.038]		0.084** [0.037]	
Real GDP per capita growth (lagged)		0.296*** [0.054]		0.200*** [0.049]
Country dummies x time trend	Yes	Yes	Yes	Yes
Country dummies x (time trend)^2	Yes	Yes	Yes	Yes
Country dummies x (time trend)^3	No	No	Yes	Yes
Number of observations	357	357	357	357
Number of countries	83	83	83	83
Specification Test[29]				
Test for fixed country effect model Ho: $b_{1i} = b_{2i} = b_{3i} = 0,$ *for all i* Log Likelihood Ratio Test	896***		1206***	

Significant at *10%; ** 5%; *** 1%, Unit of observation: 5 year averages. All estimates include time period dummies common to all countries. TVC estimates include 212 and 254 country specific coefficients for the first 2 columns and last 2 columns respectively, to capture the v_{it} effects.

[29] Similar to the TVC-FE estimates in table 1, we found that the residuals for the TVC-FE-SUR estimates in table 2 are time independent, and there is no significant correlation between the residuals and the time trend.

Table 3: Government Spending Disaggregated and per capita GDP Growth – System Estimators

	TVC-FE-SUR with 2nd order approximation of v_{it} and $\tilde{v}_{it}$		TVC-FE-SUR with 3rd order approximation of v_{it} and $\tilde{v}_{it}$	
Dependent Variable	GDP per Capita Growth	Investment over GDP	GDP per Capita Growth	Investment over GDP
Share of government PME social spending in total government Expenditures (lagged)	0.096*** [0.027]	0.139*** [0.038]	0.122*** [0.026]	0.080** [0.040]
Share of government PME non-social public good spending in total government Expenditures (lagged)	0.052 [0.058]	0.170** [0.080]	-0.049 [0.056]	0.196** [0.083]
Share of government RME economic affairs spending in total government Expenditures (lagged)	-0.116*** [0.032]	-0.018 [0.045]	-0.047 [0.036]	0.002 [0.054]
Total government consumption expenditures over GDP (lagged)	-0.160** [0.079]	0.021 [0.110]	-0.125* [0.067]	0.101 [0.101]
Total investment over GDP	0.114*** [0.037]		0.123*** [0.035]	
Real GDP per capita growth (lagged)		0.291*** [0.055]		0.169*** [0.052]
Country dummies x time trend	Yes	Yes	Yes	Yes
Country dummies x (time trend)^2	Yes	Yes	Yes	Yes
Country dummies x (time trend)^3	No	No	Yes	Yes
Number of observations	354	354	354	354
Number of countries	83	83	83	83
Specification Test[30]				
Test for fixed country effect model Ho: $b_{1i} = b_{2i} = b_{3i} = 0,$ *for all i* Log Likelihood Ratio Test	875***		1200***	

Significant at *10%; ** 5%; *** 1%, Unit of observation: 5 year averages. All estimates include time period dummies common to all countries. TVC estimates include 212 and 254 country specific coefficients for the first 2 columns and last 2 columns respectively, to capture the v_{it} effects.

[30] Similar to the TVC-FE estimates in table 1, we found that the residuals for the TVC-FE-SUR estimates in table 3 are time independent, and there is no significant correlation between the residuals and the time trend.

Table 4: Added Controls Approach (ACA)

	Two Way Fixed Effects (TWFE)		Two Way Random Effects (TWRE)	
Specification	Coef. (std. err)	Adjusted R^2	Coef. (std. err)	Adjusted R^2
<u>Base</u>	0.084*** [0.019]	0.41	0.056*** [0.011]	0.25
Added Control Sets				
<u>Governance and Institutions</u> Presidential System Dummy Quality of Government Corruption Polity Index lagged Political Competition lagged Total Tax over GDP	0.065*** [0.022]	0.39	0.044*** [0.011]	0.26
<u>Stability</u> Years of Democratic Stability lagged Log of (1+black market premium) – 1980-89 Average Average no. revolutions (1980-1995)	0.085*** [0.019]	0.40	0.053*** [0.011]	0.26
<u>Human Capital and Income Distribution</u> Gini of Education Initial Income Gini Initial Primary School Completion Rate Life Expectancy Years of Schooling lagged	0.083*** [0.021]	0.34	0.053*** [0.012]	0.28
<u>Demographics and Geography</u> Labor force size Population Density % Land in Tropical Areas	0.082*** [0.021]	0.43	0.057*** [0.012]	0.26
<u>Openness</u> Trade over GDP Primary export share of total exports in 1970	0.058*** [0.020]	0.38	0.035*** [0.011]	0.27

Significant at *10%; ** 5%; *** 1%, Unit of observation: 5 year averages. All estimates include time period dummies common to all countries. Robust standard errors in brackets.

Table A1: Variable Sources, Definitions And Countries in Sample

Variable	Description	Years Available	Source
GDP growth (2000 US$)	Real GDP per Capita growth (Constant US$ 2000)	1980 – 2009	World Development Indicators, World Bank (WDI)
Share of Government Expenditure on PME	Include: (1) Subsidies to Households: Education, Health, Social security and welfare, Housing and community amenities (2) Environmental Protection, Research and development (3) "Pure" Public Goods: Transport, Communication, Public order and safety (4) Other public goods - Religion and culture	1980 – 2009	Government Financial Statistics (IMF), Asian Development Bank, Country data
Share of Government Consumption over GDP		1980 – 2009	Penn World Tables (2011)
Share of Investment over GDP		1980 – 2009	Penn World Tables (2011)
Total Tax over GDP		1980 – 2009	Government Financial Statistics (IMF), Asian Development Bank
Years of Schooling	Average Years of Schooling of Population over 15	1980-2009 (5 year interval)	Barro and Lee (2010), updated http://www.barrolee.com/data/dataexp.htm
Trade Openness	Log of Total Trade of GDP	1980-2009	WDI
Population Density		1980-2009	WDI
Labor Force Size	Population between 15 and 64	1980-2009	WDI
Income Gini		1980-2009	WDI
Education Gini	Education Gini for total population age 15 and over	1980-2000	Thomas et. al (2001)
Primary School Completion Rate		1980-2009	WDI
Life Expectancy		1980-2009	WDI
Presidential Dummy	1 if system is considered presidential.	1980-2009	Database of Political Institutions (DPI)
Corruption Perception Index (CPI)	10-point scale where higher values indicate less corruption.	1995-2009 average	Transparency International www.transparency.org
Quality of Government Index	mean value of the ICRG governance variables "Corruption", "Law and Order" and "Bureaucracy Quality", scaled 0-1	1980-2009	International Country Risk Guide – The PRS Group http://www.icrgonline.com
Index of Democracy (Polity 2)	Score that indicates how democratic a country ranging between -10 and 10	1980-2009	Polity IV http://www.systemicpeace.org/polity/polity4.htm
Years of Democratic Stability	Square root of Durability of Polity if Polity 2>0	1980-2009	From Polity IV and updated to 2009 http://www.systemi

			cpeace.org/polity/polity4.htm
Political Competition Index	10-point scale where higher values indicate more competition.	1980-2009	From Polity IV and updated to 2009 http://www.systemicpeace.org/polity/polity4.htm
Average number of revolutions		1980-1995 average	Dollar and Kraay 2002
Logarithm of (1+black market premium)		1980-89 Average	Dollar and Kraay 2002
Primary export share of total exports in 1970			Dollar and Kraay 2002
% Land in Tropics			Sachs, Gallup, and Mellinger (1999)

Country List

Developing: Albania, Algeria, Argentina, Bangladesh, Bolivia, Botswana, Brazil, Bulgaria, Burundi, Cameroon, Chile, Colombia, Costa Rica, Croatia, Ecuador, Egypt Arab Rep., Gambia, Ghana, Honduras, Hungary, India, Indonesia, Iran Islamic Rep, Jamaica, Jordan, Kazakhstan, Kenya, Kuwait, Kyrgyz Republic, Latvia, Lesotho, Liberia, Lithuania, Malaysia, Mauritius, Mongolia, Morocco, Namibia, Nepal, Nicaragua, Niger, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Poland, Romania, Russia, Rwanda, Slovak Republic, South Africa, Sri Lanka, Syrian Arab Republic, Tajikistan, Thailand, Togo, Tunisia, Turkey, Uganda, Ukraine, Uruguay, Venezuela, Yemen, Zambia, Zimbabwe

Developed: Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hong Kong-China, Ireland, Israel, Italy, Korea Rep., Netherlands, New Zealand, Norway, Portugal, Singapore, Slovenia, Spain, Sweden, Switzerland, Trinidad and Tobago, United Arab Emirates, United Kingdom, United States

Table A2: Summary Statistics, 5 Year Averages, 1980-2009

Variable	Median	Std. Dev	Min	Max
Growth of Per Capita GDP	1.9	2.6	-7.6	9.8
Share of Government PME in Total Government Expenditures (lagged)	54.3	15.3	14.1	84.1
Share of Total Government Consumption over GDP (lagged)	9.3	4.8	2.9	36.9
Share of Investment over GDP	21.9	7.6	6.3	59.6
Tax over GDP	17.7	8.0	1.0	56.8
Years of Schooling	7.4	2.7	0.5	12.7
% Land In Tropics	6.8	41.1	0.0	100.0
Index of Democracy (Polity 2)	8	6.7	-9.0	10.0
Political Competition Index	9	3.4	0.5	10.0
Years of Democratic Stability	2.8	3.5	0.0	13.9
Population aged between 15 and 64 (in millions)	6.8	68.6	0.36	710
Initial Income Gini	36.1	10.9	19.4	74.3
Population Density	66.0	727.4	1.5	6615.6
Presidential Dummy			0	1
Corruption Perception Index (CPI)	4.6	2.4	1.7	9.6
Quality of Government Index	0.6	0.2	0.1	1
Average number of revolutions	0.1	0.3	0	2
Logarithm of (1+black market premium)	0.1	0.7	-0.01	6.9
Education Gini	0.4	0.2	0.1	0.9
Primary School Completion Rate	92.6	18.3	13.6	109.3
Life Expectancy	71.8	8.6	39.8	82.2
Primary export share of total exports in 1970	80	31.4	1	100
Total Trade over GDP	66.8	47.7	13.8	423.6

Table A3: Composition Of Government Expenditures (% Of Total Spending)

	PME expenditures		RME expenditures
	Social Subsidies	Other PME	Subsidies to Firms
Sample Average	47	8	44
Period Averages			
1980-1989	43	8	50
1990-1999	47	9	45
2000-2009	51	9	40
Top Third (based on PME)	64	7	28
Middle Third	48	9	43
Bottom Third	29	10	63
PME: Top 3 countries			
Slovenia	71	9	20
New Zealand	72	8	21
Croatia	65	12	22
PME: Bottom 3 countries			
Syrian Arab Republic	18	4	77
South Africa	18	9	73
Peru	22	5	72

Social subsidies include Education, Health, Social Security and welfare, Public Housing, Religion and Culture, and social transfers. Other PME include: Environmental Protection, Research and Development, Public Order and Safety, Transport and Communication. Direct subsidies to firms include Economic Affairs (excluding Transport and Communication). Administration expenditures are included in each category.

Table A4: Government Spending and per capita GDP Growth – Dynamic Specification

	GMM Un-collapsed Instruments	GMM Collapsed Instruments
Share of government PME in total government Expenditures (lagged)	0.059*** [0.011]	0.056*** [0.011]
Total government consumption expenditures over GDP (lagged)	-0.028 [0.037]	-0.018 [0.040]
Total investment over GDP	0.070*** [0.021]	0.066*** [0.020]
Log of Initial per capita GDP	0.011 [0.018]	0.013 [0.018]
Federal Dummy	-0.008** [0.003]	-0.008** [0.003]
Lagged GDP per Capita Growth	0.043 [0.060]	0.077 [0.065]
Hansen Test (P-value)	0.207	0.210
Arellano-Bond test for AR(2) in first differences	0.206	0.248
Number of Observations	369	369
Number of Countries	95	95

Significant at *10%; ** 5%; *** 1%, Unit of observation: 5 year averages. Robust standard errors in brackets; All estimates include time period dummies common to all countries.

APPENDIX I. Chapter 3: Proof of Lemmas

Proof of Lemma 1

Part (i). The worker maximizes the present discounted value of her utility over period 0 ($u(c_0)$) and period 1 ($u(c_1)/(1+\rho)$) by choosing the optimal levels of borrowing (B) and a dollar value equal to h of investment in human capital in period 0, subject to the budget constraints in period 0 $(c_0 = w_0 + s_0 + B - h)$ In period 1 the worker does not invest and thus the budget constraint is $c_1 = (1+\psi(h))w - (1+r^f)B$). c_1 and c_0 denote the levels of consumption in period 0 and 1 respectively, ρ is the time discount rate, and w_0 is the market wage rate for unskilled workers in period 0. Unconstrained workers can borrow ($B \geq 0$) while constrained workers cannot ($B = 0$). Assuming an interior solution, the first order conditions for the financially-*unconstrained* workers (i.e., those with $s_0 \geq \overline{s}$) are:

(B1) $$u'(c_0) - ((1+r^f)/(1+\rho))u'(c_1) = 0,$$

(B2) $$-u'(c_0) + (\psi'(h)w_0/(1+\rho))u'(c_1) = 0.$$

Combining (B1) and (B2) yields,

(B3) $$\psi'(h^u)w_0 = 1 + r^f.$$

Equation (B3) implies that an unconstrained worker's human capital investment is unaffected by her initial wealth level ($\partial h^u / \partial s_0 = 0$). Financially-constrained workers are affected by a binding borrowing restriction, which implies that the marginal net present value of the utility of B is positive. Therefore,

(B4) $$u'(c_0) - ((1+r^f)/(1+\rho))u'(c_1) > 0 .$$

(B2) holds for financially-constrained workers as long as their human capital investment is positive ($h^c > 0$). The marginal cost of investing in h for financially-constrained workers equals their own internal marginal cost of saving ($u'(c_0)(1+\rho)/u'(c_1)$) and for financially-unconstrained workers it equals the market cost of capital ($1+r^f$). By (B4) the internal marginal cost of money is higher than the market cost of capital. Thus, using (B2) and (B4) we get,

(B5) $$\psi'(h^c)w_0 > 1+r^f .$$

This implies that $\psi'(h^c) > \psi'(h^u)$. By assumption A.4, $\partial^2 \psi / \partial h^2 < 0$, which implies that $\psi(h^u) > \psi(h^c)$. ⊗

Part (ii). The internal marginal cost of money, $u'(c_0)(1+\rho)/u'(c_1)$, is decreasing in the level of wealth, s_0. The strict concavity of $\psi(h)$ in human capital investment (h) implies $\partial h^c / \partial s_0 > 0$. Hence, human capital investment by financially-constrained workers is increasing in their level of initial wealth. ⊗

Proof of Lemma 3

Part (i). From the profit maximization for unconstrained firms, we have the first order condition with respect to labor or human capital:

(B6) $$af_2(l_j / k_j) = w,$$

where f_2 denotes the first derivative with respect to human capital. f_2 is homogenous of degree zero and thus expressed as a function of the factor ratio (l_j / k_j). Let own financial capital for constrained and unconstrained firms be $\chi_c \geq 0$ and $\chi_u \geq 0$ respectively, so that for financially-unconstrained (constrained) firms total initial wealth is $\chi_u \geq \bar{k}$ ($\chi_c < \bar{k}$), where $\bar{k}$ is the minimum critical level of total owned wealth by the firm for accessing capital markets. Constrained firms can choose labor freely, as the financial constraint does not affect their choice of variable inputs, and are assumed to face the same composite wage rate as financially-unconstrained firms. Hence, financially-constrained firms will maximize profit by equalizing the marginal product of human capital to the market wage rate,

(B7) $$af_2(l_j / k_j) = w.$$

From equations (B6) and (B7) it follows that as long as unconstrained and constrained firms face the same wage rate, the financially constrained firms reach the same human capital/physical capital ratio as the unconstrained firms, $(l_c / \chi_c)^E = (l_j / k_j)^E$. ⊗

Part (ii). From the profit maximization for unconstrained firms, we have the first order condition with respect to physical capital:

(B8) $$af_1(l_j / k_j) = r^f,$$

where f_1 is the first derivative of f with respect to physical capital. f_1 is homogenous of degree zero and thus f_1 can also be expressed as a function of only l_j / k_j. Thus, from condition (B8) we obtain,

$$\text{(B9)} \qquad (l_j / k_j)^E = \phi(r^f / a),$$

where the function ϕ is increasing in r^f / a. Using (B9) in (B6) we obtain the equilibrium composite wage rate,

$$\text{(B10)} \qquad w^E = w^E(a, r^f / a),$$

where w^E is increasing in a and decreasing in r^f. ⊗

Part (iii). From the profit maximization for unconstrained firms, we have the first order condition with respect to human capital and physical capital employed in rent seeking activities:

$$\text{(B11)} \qquad R_1(k_j^M / M, l_j^M / M) = r^f$$

$$\text{(B12)} \qquad R_2(k_j^M / M, l_j^M / M) = w^E,$$

where R_1 and R_2 denote the first derivatives with respect to physical capital and human capital employed in rent seeking activities, respectively. The marginal products of the factors of production devoted to rent seeking are functions of the k_j^M / M and l_j^M / M ratios because the function $R(k_j^M, l_j^M; M)$ is linearly homogenous. Equations (B11) and (B12) then solve, (B13) (a) $l_j^M / M = \zeta^L(w^E, r^f)$; (b) $k_j^M / M = \zeta^K(w^E, r^f)$

Where $\zeta^L(\zeta^K)$ is decreasing (increasing) in w^E, and increasing (decreasing) in r^f. ⊗

Proof of Lemma 6

The constant elasticity of substitution (CES) production function for the economy is

$$y_j = a[\alpha k_j^{-\frac{(1-\sigma)}{\sigma}} + (1-\alpha) l_j^{-\frac{(1-\sigma)}{\sigma}}]^{-\frac{\sigma}{(1-\sigma)}},$$

where $\sigma < 1$ is the elasticity of substitution. From lemma 3(i) and lemma 3(ii) we have,

(B14) $$(l_j / k_j)^E = (l_c / \chi_c)^E = \left[\left(\frac{r^f}{\alpha a}\right)^{\sigma-1} - \alpha\right]^{-\frac{\sigma}{(1-\sigma)}} /(1-\alpha) \ ,$$

Using (B14) in (4) and (5) we obtain,

(B15) $$\left[\left(\frac{r^f}{\alpha a}\right)^{\sigma-1} - \alpha\right]^{-\frac{\sigma}{(1-\sigma)}} K^E = (1-\alpha)(L^S - L^M);$$ (B16)

$$Y = a^{1-\sigma}\left(r^f / \alpha\right)^{\sigma} K^E$$

By logarithmically differentiating (B15) and (B16) with respect to time, we derive the following growth specifications in lemma 6: $g^k = g^{L^S - L^M} + \sigma\varpi(g^a - g^{r^f})$, and $g^y = (1-\sigma)g^a + g^k + \sigma g^{r^f}$. ⊗

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