Output and the Composition of Government Spending in India

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Abstract

This paper uses a Cobb-Douglas production function to analyze the role of government spending in the Indian economy and tries to determine how different categories of spending affect growth outcomes. Government spending is hypothesized to influence output and growth through two channels, by affecting the level of TFP and the level of output, and by influencing the growth rate of TFP. The model assumes that TFP is a function of levels of government spending and time. Using annual aggregate data for India from 1961-2002, it is found that government spending depresses per capita GDP. Increasing health and agriculture spending leads to a decrease in output, while increasing infrastructure and education spending improves output. The estimates using data from industries were similar and the growth effect of government spending was found to be negative.

1. Introduction

Government spending has been found to be an important determinant of growth for many countries. It can affect growth through a number of channels by improving the quality of human capital, improving infrastructure in the country, or it could even hurt the economy by promoting corruption and large, inefficient bureaucracies. Barro (1990) explored the relationship between government expenditure and growth in a number of his works and found it to be negative one. However, his papers mainly look at the share of government spending in GDP and only explain the effect of the size of government on growth.

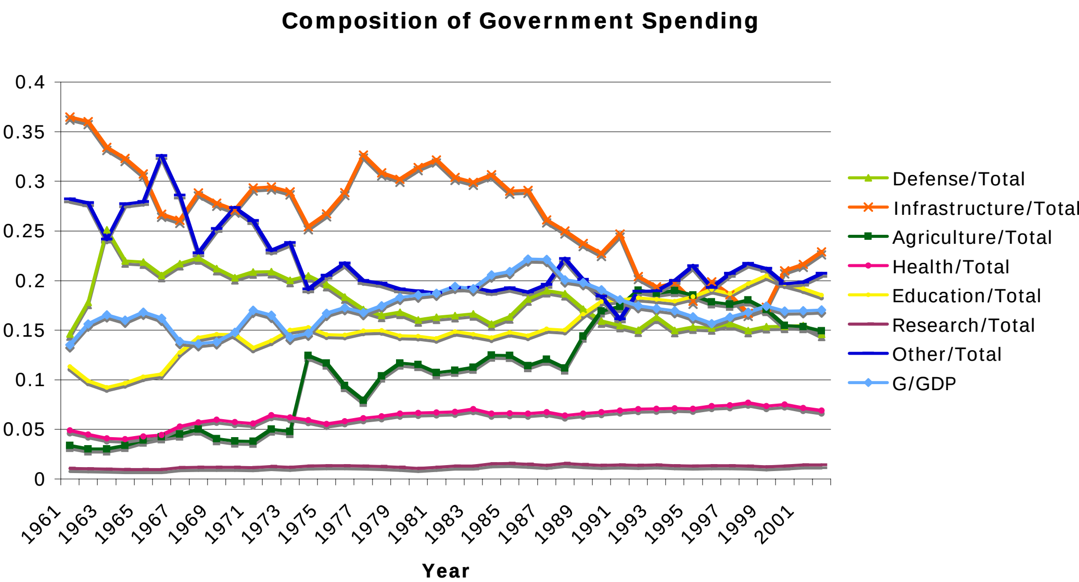
This paper contends that rather than simply looking at the ratio of government expenditure to GDP, it would be more informative to analyze how different categories of government spending influence growth outcomes. The idea being that it is not only the size of the government that affects the health of the economy but also the nature of the government's activities. Thus, rather than simply focusing on the size of government, we must also focus on the distribution of the spending. It seems like that government spending is made up of some components that are productive and some that are unproductive. Countries whose governments undertake more productive expenditure are more likely to grow faster. Rather than simply terming government spending as a whole to hurt development, it is essential to determine which components are the most productive. There has been significant literature measuring this impact for panels of countries. In the present context, this would amount to assuming that different categories of government spending are equally productive in different countries. This paper avoids this assumption by focusing on a single country: India.

A country like India runs extremely large fiscal deficits because of the various development programs that are a part of its spending. The productivity of public spending assumes even more importance for developing countries like India, as by calculating it and ascertaining its role in the economy governments can develop better ways to utilize their budgets. This will help them to contain their budget deficits that can destabilize growth in many situations. It is with this point in mind that this paper examines the productivity of government spending for India from the post-independence period to the present. Conducting such an exercise will help the country in the overall development process by enabling the government to identify and limit wasteful expenditures, reduce taxes, in turn allowing citizens to channel resources to more productive uses in the private sector.

In addition to focusing on the impact of different types of government spending on output, this paper takes a unique approach to evaluating government spending by calculating the productivities for the economy as a whole and for different industries that comprise of the economy such as agriculture, manufacturing, services etc. Thus, the underlying hypothesis is that government spending probably affects different industries through different mechanisms. Spending that promotes agricultural output may not necessarily promote manufacturing. By determining which expenditures help which industries, the planning authorities can then develop mechanisms to strategically support certain industries. In addition, they can develop plans to prioritize some industries over others.

Another motivation behind examining this subject is to determine how the changes in the composition of spending over time could affect output. Over time, the

Figure 1.1



composition of government activity has changed radically in India. Figure 1.1 gives some indication of what those changes have been. Most noticeably, the share of infrastructure spending has decreased from around 37% in 1961 to 27% in 2002. On the other hand, the share of education saw a modest increase from 12% to 18% and that of agriculture saw a large increase from 3% to 15%. However, the share of government spending as a percentage of GDP does not fluctuate much, starting at around 13% in 1961, increasing to 23% in 1987, and then decreasing to 17% in 2002. By assessing the productivities of these categories of spending, it will be possible to understand their effects.

India's economic planning from 1947 to 1990 was based on socialist theories. As such, the public sector was an extremely large undertaking in the socialist era and the government was responsible for the industrialization of the country by producing many of goods and services. At the same time, the government was also marked with inefficiencies because of the large and unwieldy bureaucracies that it created. Private enterprise was discouraged through a system of licensing and a very high tax rate. This was accompanied by large infrastructural and development spending programs targeted at improving the economic status of the majority of the population that was living in poverty. A foreign exchange crisis in 1990 forced the government to introduce reforms to change the outdated and protectionist policies. The government has greatly reduced its involvement in the industrial sector by opening it up to private businesses. By examining the productivity of government spending categories, both before and after the reforms, this paper attempts to determine whether any noticeable effects can be measured as a result of economic reform.

Government spending is hypothesized to influence output and growth through two channels, both work by altering total factor productivity (TFP). First, government spending may affect the level of TFP and the level of output, thus impacting growth onto the extent that government spending itself is growing. The level of government spending may also influence growth rates directly by altering the growth rate of TFP. For example, higher education spending may spur growth in TFP. Both channels are tested here.

In all, this paper presents a comprehensive analysis of the role of government spending in the Indian economy by examining various different ways in which it can affect output. The rest of the paper is organized as follows: Section 2 provides a review of the literature. Section 3 discusses the basic empirical methodology. Section 4 details the sources for data. Section 5 presents the empirical results using level data. Section 6 reports the results for industry data. Section 7 utilizes dummy variables to provide further insight into the analysis. Section 8 explores the growth channel and Section 9 summarizes and discusses the results.

2. Literature Review

There is a large volume of literature that looks at the growth effects of government expenditure as well as its effect on Total Factor Productivity. While there is much work assessing how different components of government expenditure affect growth outcomes, there are only a few that look at this relationship specifically in terms of the effects of government spending on industry-wise output. The papers discussed in this section can be broadly categorized into two categories. The first deals with papers that explore the relationship between growth or output and public expenditure and the second assesses those papers that provided methodologies that could be pursued in this paper.

The papers that estimated the impact of government spending on per capita growth rates were similar in that most of them found that most components of government spending depressed growth rates. Table 2.1 provides a summary of the findings and is followed by a detailed discussion of the methodologies and results.

Landau (1983) tries to explain the relationship between government consumption expenditure and the rate of growth of real per capita GDP. He used data for 96 countries (excluding oil exporting countries and communist countries) from 1961-1976. He hypothesizes that higher consumption expenditure must come at the expense of investment or private consumption, but also points out that often parts of government consumption are actually investment in health and education and that similarly, private consumption also includes private investment. Nevertheless, his finding that there is a negative relationship between government consumption and per capita GDP growth rates is consistent with the free market idea that "growth of government hurts economic growth" (Landau 1983). On the other hand, expenditure on education is found to have a

Table 2.1
Summary of Literature Findings

Paper	*Category of Spending*	*Effect*
Landau (1983)	G/GDP	Negative
	Education	Positive
Landau (1986)	Other	Negative
	Education	Positive
	Transfers	Positive
	Capital	Positive
Aschauer (1989)	Infrastructure	Positive
Devarajan (1993)	Current Expenditure	Positive
	Capital Expenditure	Negative
	Defense	Negative
	Health	Negative
	• Public Health	• Positive
	Education	Negative
	• Educational Infrastructure	• Positive
Evans & Karas (1994)	Education	Positive
	Current Expenditures	Positive
	Capital Expenditures	Negative
Baffes & Shah (1998)	Human Capital	Positive
	Defense Capital	Negative (in dvlpg countries)
	Infrastructure	Positive
Hansson & Henrekson (1994)	Government Consumption	Negative
	Government Investment	Negative
	Social Security	Negative
	Education	Positive
Wyatt (2005)	Defense	Positive (not significant)
	Education	Negative
	Health	Positive (not significant)
	Economic	Positive
	Administrative	Positive (not significant)

positive effect on growth rates. Landau (1986) attempts to recreate the same study but for developing countries and he uses additional variables such as Transfers and Capital spending. His findings do not radically differ from his previous study but he does find that Transfers and Capital spending have a positive effect on growth.

Aschauer (1989) conducted a detailed study of the kinds of public investments a government should take to maximize productivity using data for G-7 countries[1] from 1949-85. He also used a production function approach and finds that it is the "core" infrastructure spending that has the greatest positive effects on productivity. By "core" infrastructure he means the provision of streets, highways, electricity, gas facilities, water systems. Aschauer hypothesizes that infrastructure spending helps productivity by improving the utilization of inputs, in effect, improving the level of technology in the economy.

Devarajan et al. (1993) explore how the composition of public expenditure affects economic growth and they show how an increase in productive expenditure leads to a higher steady-state growth rate of the economy. Their sample consisted of data for 69 developing countries, from 1970 to 1990. They do so by determining which government expenditures are productive or unproductive expenditures. Thus, they include capital and current expenditure, defense, health and education to assess which spending is the most productive, their definition of productive being that it positively affects the per capita GDP growth rate. Their results indicate that only current expenditure has positive effects, while capital expenditure, defense, health and education have negative effects[2]. However,

[1] United States, Japan, Germany, France, United Kingdom, Italy and Canada

[2] Current expenditure refers to recurring spending, that is, spending on items that are consumed such as wages and salaries, stationery, drugs for health services and so on. On the other hand capital expenditure is spending on assets that will last and will be used again such as roads, buildings, computer equipment.

many of the coefficients they calculate are insignificant and this probably is a result of other defects in their model such as model misspecification or poor data. They do make the model more complex, by further disaggregating government spending, in which case they find that spending on public health is productive as is spending on educational infrastructure.

In an analysis of data from a panel of U.S. states covering the period 1970 to 1986, Evans and Karras (1994) find that current education expenditures are productive while capital expenditures actually diminish productivity. They disaggregate government spending into a variety of components such as educational, highway, health and hospital, policy and fire, sewer and sanitation services. Their model provides a fairly comprehensive idea of the role these expenditures play when determining productivity. At the same time they only focus on manufacturing output and the effects of government spending on manufacturing. However, they do point out that even though most government expenditures are un-productive, that does not mean we should eliminate them as we do not know what the alternative is, especially if the government is assuming an important non-market role.

Lastly, Baffes and Shah (1998) focus largely on the effects of different kinds of investment on per capita GDP for 21 countries from 1965-1984. In doing so they compute the scale elasticities of various inputs and conclude that most countries experience increasing returns to scale and that most inputs have an elasticity greater than 1. Their findings also indicate that human resource-development capital has the highest impact on output, followed by private capital and labor. Defense capital had a negative impact in half the countries, especially in developing ones, while infrastructure capital had a weak, but positive impact.

The next few papers discussed concern the methodological issues that are related to determining the productivity of government spending. Andrew Hughes' "Guide to the Measurement of Government Productivity" lists the various approaches one can take towards estimating the variable but does not apply those methods to any particular study. The methods he identifies included three methods of estimation: 1) determining the Total Factor Productivity (TFP) indexes, 2) using OLS or Stochastic Frontier Analysis or 3) using Data Envelopment Analysis. Within these, two main approaches could be used towards calculating the productivity of government spending either by estimating the variable $\partial GDP/\partial G$ or by looking at the effect of government spending on Total Factor Productivity (TFP) growth. Thus, the former approach looks solely at how productive government spending is in its production of goods and services, and the latter looks at how government spending contributes to the productivity of the economy as a whole.

The first approach is used by Leightner (2005) in "The Productivity of Government Spending in Asia: 1983 – 2000" in which he uses a Reiterative Truncated Projected Least Squares estimation to produce an estimate for the impact of changes in government spending on GDP for every year for 24 Asian countries, including India. His paper relies extensively on the strengths of the RTPLS model and lacks a more intuitive model to explain how and why GDP changes for a change in G. He estimates the productivity of government spending to fall between 8.01 and 8.24, indicating that a one unit increase in government spending leads to around an 8 unit increase in GDP. However, his results are hard to interpret in relation to other factors that may also be affecting GDP, as one does not know what role G takes in the economy. Furthermore, his results also conflict with the finds of the other papers discussed in this literature review.

Ahmed (1986) employs a very different model in and this is probably because the primary purpose of his paper is to distinguish between the effects of permanent and temporary changes in government spending on the trade balance. Nevertheless, his model offers certain advantages for this paper as his focus is on a single country. His estimate for the marginal productivity of government spending in the United Kingdom for the period 1908-1980 is positive but is much smaller than Leightner's at .39. His method is also superior to Leightner's as it creates a framework for understanding the role of government spending in the economy. Since this paper does not intend to capture the effects of changes in the marginal productivity of government spending but to see how different compositions of it can affect its productivity, the Ahmed model would be too narrow to use. Ahmed too, concedes this point in his discussion where he recognizes that the relative composition of spending should not change in order for his results to represent the average productivity.

The second method was developed by Hansson and Henrekson and later improved upon by Geoffrey Wyatt. They both look at the effects of government expenditure through the production function. Hansson and Henrekson (1994) create the basis of the model that Wyatt used in his paper. They choose to look at the private sector and assess how government spending affects it. In order to do so, they devise the idea of using disaggregated data of various industries in the OECD countries from 1970-1987. This is the most valuable part of their paper, which Wyatt develops with a more sophisticated model. In addition, they discuss some of the causal mechanisms through which government spending can either positively or negatively affect productivity. They find that a majority of government spending (Government Investment, Transfers and Social Security) has a negative effect on growth and productivity, and that education has a positive effect. However, their model has several flaws in that it does not have the benefits that they claim it has: firstly, it does not account for the fact that government spending is a part of GDP, and secondly, it is impossible to prove that the effects of government spending act through TFP and not through the marginal productivity of labor and capital.

Wyatt (2005) conducts his study for OECD countries over 1970-1987 and produces results for the contribution of various categories of government spending such as defense, education, health etc. Wyatt uses the endogenous growth model and estimates the effect of government spending through the equation $Y_{ijt} = A_i(g_{1jt}, g_{2jt} ... g_{mjt}; t, d_{ij}) F_i(K_{ijt}, L_{ijt})$, where Y_{ijt} is output for industry *i,* in country *j,* at time *t*, *K* is capital, *L* is labor, *A* is TFP and is a function of *m* categories of national government expenditure, *t* is technical progress and *d* is a dummy variable for each country. He then specifies the function *A* and uses GLS to estimate coefficients for the various *g* values. His conclusions, especially because he divides the effect of government spending into scale and compositional effects, are of great value to this paper and indicate that government spending "depresses the GDP level and the growth of productivity". Furthermore, Wyatt finds that education spending has a negative effect on output and his findings for health and defense spending are not significant.

Other research that has been done using this method includes that of Devereux, Head and Lapham (1996). They assume monopolistic competition and increasing returns in the economy and find that government spending can improve productivity even when it is entirely wasteful. This is a rather counter-intuitive result and it reflects the possibility where government spending improves TFP by increasing consumption, which increases welfare levels in the economy. In a study of the effectiveness of government spending in rural India, Fan, Hazell and Thorat (2000) find that it is the most productive when used in basic rural infrastructure like roads and agricultural technology than when directed to other avenues such as education or health. This study does not consider the economy as a whole but does reveal good sources for finding data on India. Lastly, Tulsidharan (2006) looks specifically at India and finds that higher economic growth is accompanied by an increase in the government's expenditures. However, he does not succeed in proving which way the causality works between the two variables.

3. Methodology

Having examined the existing literature and knowledge on the subject, the Wyatt model seems to be the best approach to achieve the objectives outlined in this paper. This methodology is used to determine the productivity of government spending variables for the Indian economy as a whole and then for some of the main industries in the Indian economy, ranging from agriculture, services and manufacturing to communication, construction, and trade, providing a rigorous assessment of the role of those variables. This is done using annual data from 1960 to 2005.

The particular advantage of Wyatt's model, mentioned earlier and emphasized in greater detail here, is the ability to disaggregate government spending. This factor is integral to this study which estimates the effects of changes in the composition of government spending. By specifying TFP as a function of different kinds of government spending (g_m), it is possible to determine various coefficients that represent the contribution of each type of spending, m. This solves the drawbacks of Ahmed's model that seemed attractive except for this feature.

The basis of the model is a Cobb-Douglas production function with constant returns to scale. Thus, one of the major tasks of this paper has been deciding what specification to prescribe for Total Factor Productivity (A). Wyatt simply makes Total Factor Productivity a function of the different government spending categories, time and a dummy variable for each state. This is because he looks at more than one country and can thus rely on the various different factors across countries to determine the coefficients. While other variables were considered, in the end the same specification as Wyatt's was used, by making A a function of levels of government spending and time (the country dummy variable was eliminated). Thus, the model mirrors Wyatt's except for the fact that the data only reflects one country. To replicate Wyatt's model, the use of state-level data from India's 28 states was considered. Moreover statewide data would be very beneficial because it would add greater robustness to my findings by providing more observations. However, it was not possible to find detailed industry or labor data for the states and this limited the options available.

The foundation of the model starts with a Cobb-Douglas production function:

$$Y_t = f(K,L) = AK^{\beta}L^{1-\beta}; \ (1)$$

where Y_t is output in period *t*, K_t is capital in period *t*, L_t is labor in period *t, A* determines Total Factor Productivity in the economy, and β is capital's share in the economy. In order to express how government spending affects productivity, *A* is taken to be a function of the various kinds of government spending. This yields the following specification:

$$Y_t = A(\frac{G_t}{Y_t}, g_{1t}g_{2t},...,g_{mt},t)K^{\beta}L^{1-\beta} \quad (2), \text{ and,}$$

$$A = e^{\alpha_0+\gamma t+\varepsilon_t}\left(\frac{G_t}{Y_t}\right)^{\theta} g_{1t}^{\alpha_1}g_{2t}^{\alpha_2}....g_{mt}^{\alpha_m} = e^{\alpha_0+\gamma t+\varepsilon_t}g_t^{\theta}g_{1t}^{\alpha_1}g_{2t}^{\alpha_2}....g_{mt}^{\alpha_m} \ (3),$$

where G_t is total government spending; as such g_t is the size of government with respect to the economy (Y) and $g_t = \frac{G_t}{Y_t}$. The g_{it} variables are different categories of government spending like health, education and defense as shares of GDP. There are *m* such categories. *t* is intended to capture technical progress. The TFP function *A* is assumed to take the form $A = e^{\alpha_0+\gamma t+\varepsilon_t}\left(\frac{G_t}{Y_t}\right)^{\theta} g_{1t}^{\alpha_1}g_{2t}^{\alpha_2}....g_{mt}^{\alpha_m} = e^{\alpha_0+\gamma t+\varepsilon_t}g_t^{\theta}g_{1t}^{\alpha_1}g_{2t}^{\alpha_2}....g_{mt}^{\alpha_m}$. The coefficient θ through γ represents the GDP growth rate over the period; the coefficient θ, thus represents the productivity of overall government spending while the α_i's capture the impact of the *m* different types of government spending. Finally, ε_t is a uniformly distributed error term with a mean of zero. The production function is now:

$$Y_t = e^{\alpha_0 + \gamma t + \varepsilon_t} g_t^{\theta} g_{1t}^{\alpha_1} g_{2t}^{\alpha_2} \ldots . g_{mt}^{\alpha_m} K_t^{\beta} L_t^{1-\beta} \text{ (4).}$$

Hereafter, I modify this equation to create a function of output on a per worker basis. This simply involves dividing the function by L_t to yield:

$$y_t = e^{\alpha_0 + \gamma t + \varepsilon_t} g_t^{\theta} g_{1t}^{\alpha_1} g_{2t}^{\alpha_2} \ldots . g_{mt}^{\alpha_m} k_t^{\beta} \text{ (5),}$$

where, y_t is output per worker $\left(y_t = \dfrac{Y_t}{L_t} \right)$ and k_t is capital per worker $\left(k_t = \dfrac{K_t}{L_t} \right)$.

The natural log of both sides of the equation is taken to create the log-log specification:

$$\ln y_t = \alpha_0 + \gamma t + \beta \ln k_t + \theta \ln g_t + \sum_{i=1}^{m} \alpha_i \ln g_{it} + \varepsilon_t \text{ (6).}$$

The coefficients can now be thought of as the elasticity of a variable with respect to output. For example a 1% increase in g_t causes y_t to increase by θ%.

When Wyatt arrives at equations (6) he makes the assumption that the production function is homogenous of degree zero in the different categories of government spending. That is, he assumes:

$$\alpha_1 + \alpha_1 + \ldots + \alpha_m = 0.$$

Without this assumption, the coefficient α_i in a regression like (6) would be attempting to measure the impact of a change in g_i on output holding the shares of all other categories of spending constant as well as the total share of government spending constant. This is not possible since $g = \sum_{i=1}^{m} g_i$ must hold. Hence, we have:

$$g_{mt}^{\alpha_m} = g_{mt}^{-\alpha_1} g_{mt}^{-\alpha_2} \ldots g_{m}^{-\alpha_{m-1}}, \text{ and therefore}$$

$$A = e^{\alpha_0 + \gamma t + \varepsilon_t} g_t^{\theta} \left(\frac{g_{1t}}{g_{mt}} \right)^{\alpha_1} \left(\frac{g_{2t}}{g_{mt}} \right)^{\alpha_2} \ldots \left(\frac{g_{(m-1)t}}{g_{mt}} \right)^{\alpha_{m-1}}$$

This eliminates one of the categories of government spending from the estimated regression and removes a possible multicollinearity problem as well. Note that the impact of the omitted category is simply $\alpha_m = -\sum_{i=1}^{m-1} \alpha_i$. When interpreting the coefficients such as α_1, it is the effect of increasing the ratio $\frac{g_{1t}}{g_{mt}}$ keeping $\frac{g_{2t}}{g_{mt}}$ through $\frac{g_{(m-1)t}}{g_{mt}}$ and g_t constant. This can be achieved by increasing g_{1t} while decreasing g_{mt} and simultaneously decreasing g_{2t} through $g_{(m-1)t}$ so as to keep the ratios $\frac{g_{2t}}{g_{mt}}$ through $\frac{g_{(m-1)t}}{g_{mt}}$ constant. This assumption on A changes equation (6) to

$$\ln y_t = \alpha_0 + \gamma t + \theta \ln g_t + \sum_{i=1}^{m-1} \alpha_i \ln \left(\frac{g_{it}}{g_{mt}} \right) + \beta \ln k_t + \varepsilon_t \quad (7)$$

The coefficients α_1 through α_m allow one to calculate the effect of changing $\frac{g_i}{g_m}$ on output. Thus, a 1% increase in $\frac{g_1}{g_m}$ would produce an α_1% increase in y_t.

Thus far, the model presented considers the effects of government spending on the productivity of the Indian economy as a whole. But going back to one of the assumptions that Wyatt makes, it seems reasonable to say that if government spending does in fact affect productivity, it must do so through the non-government sector or through microeconomic mechanisms. As mentioned earlier, the main objective of this paper is to assess the effect of government spending for some of the major industries in the Indian economy and therefore the model must be further modified to account for this.

In doing so, however, the assumption is made that the functional form of the production function across industries is similar to that used in the baseline model just outlined. Doing so, alters equations (7) in the following way:

$$\ln y_{jt} = \alpha_{j0} + \gamma_j t + \theta_j \ln g_t + \sum_{i=1}^{m-1} \alpha_{ij} \ln\left(\frac{g_{it}}{g_{mt}}\right) + \beta_j \ln k_{jt} + \varepsilon_{jt} \quad (8),$$

where *j* represents the different industries that are a part of output in the Indian economy.

Following this, an OLS regression was used to estimate the coefficients of the variables α_{0j}, α_{1j},… α_{mj}, γ_t, β_j , and θ_j. Thus, *j* regressions (where *j* depends on the number of industries used) were run and *m* productivity coefficients were calculated resulting in a total of $m \times j$ parameters being evaluated. This method created very large data demands because it requires at least 40 observations for each industry category. This was easier for Wyatt to handle as he used 14 countries in his dataset and was using OECD countries that generally do not have data availability issues. However, when studying a single country it is essential to use historical data.

Alternatively, another model was considered that involved running a regression that would produce only one coefficient for each type of government spending. This would involve treating the data as panel data and then industry dummy variables to control for the differences between industries. Such an estimation would not require as much historical data but would provide much less detailed results. Unfortunately, by doing so, it would not be possible to determine where the Indian government was contributing the most to productivity, and where it was contributing the least. However, since data availability was not a very significant issue, detailed industry and government spending data from 1961-2002 was found, this option did not need to be used.

4. Data Sources & Methods

The estimation of equations (7) and (8) created data demands for the variables discussed below. In addition to identifying the sources of data, an explanation is also provided of the ways in which data was aggregated and manipulated to create variables that are easy to deal with. An important fact to note is that Indian data is calculated for a fiscal year that begins in April and ends in March of the next year. This paper's notation is more lax. As such, if data is from 1993, it actually refers to data collected from the fiscal year starting on April 1st 1993 and ending on March 30th 1994.

a) *Output by industry*: GDP data that goes back to 1950 was available both at the sector (primary, secondary and tertiary) level and the industry level. The former is published by the World Bank in their World Development Indicators Database, while the latter was available at the website: http://www.indiastats.com/ where it was gathered from the Indian Ministry of Statistics and Implementation. Some of the industries included in this database were agriculture, mining, manufacturing, construction, and communication. This was all available at 1993 prices and all the data used in this paper is at 1993 prices. Appendix B contains a graph that shows the composition of GDP by industry over time. Table 4.1 describes the industries for which yearly output data was available.

b) *Capital by industry*: Data for the capital stock of India by industry was available going back to 1990 at the same database where the GDP statistics were found. Data on the Net Fixed Capital Stock was available from 1951-2004 at 1993 prices. The Net Fixed Capital Stock data was used even though it probably underestimates actual capital as it does not include inventory estimates. Net Capital Stock data was only

Table 4.1
Sectors and Industries of India[3]

Sector	*Share of GDP*	*Share of Employment*	*Industry Categories*
1. Primary	19%	60%	Agriculture, Forestry & Fishing
			Mining & Quarrying
2. Secondary	28%	17%	Manufacturing
			Electricity, Gas & Water Supply
			Construction
			Transportation, Storage & Communication
3. Tertiary	54%	23%	Financing, Insurance & Business
			Community, Social & Personal Services
			Trade, Hotels & Restaurants

available from 1992-2005 and hence that was not used. All the capital data was disaggregated into the same industries as the output data and was also collected from the Indian Ministry of Statistics and Implementation.

c) *Labor force or employment by industry*: Finding sound and detailed labor data was problematic but a few sources were available.

- The WDI database had some employment figures that were discontinuous and divided by sectors not industries.
- The Indian Labor Bureau issued a report every year from 1961 to 1993 known as Indian Labour Statistics. This source contained fairly continuous data that was very detailed and was divided into the same industries as the GDP and capital data. The exception was data for the Finance, Insurance & Real Estate industry, which was missing for certain years. However, upon further examination it was determined that the data was not sound as it stated employment in India in 2002 to be roughly 27 million workers. Logically, this is not possible for a country that has a population of over 1 billion people. Nevertheless, the composition (shares)

[3] Data is from the CIA World Factbook.

of individual industries as a percentage of the whole seemed to be accurate and might be later used.

- Data from Indiastat.com was collected from the Indian Labor Bureau and was reported for the year 1993-2003. It was divided into the same industries as the data from the Indian Labour Statistics books and was used in conjunction with those statistics to generate the shares of employment by industry.
- The International Labor Organization's database LABORSTA had data collected from Indian census data. These numbers were more sound but and are only provided for 1951, 1961, 1971, 1981, and 1991. The industries it is divided into were similar to the GDP industries and the estimates matched those of the Indian Labour Statistics.
- The last source was the Total Economy Database. Their data ranged from 1961 to 2005 but was only for employment in the overall economy and not for industry. The numbers are reliable and hence they were used for the regressions that included all industries.

As good data for industry employment was not available, it was projected using the ratios calculated from the Indian Labour Statistics books. A detailed explanation of this method is provided in Appendix C.

d) *Government spending by function*: This data was published at Indiastat.com and was collected from the Indian Ministry of Finance. It is available from 1960-2004. The data is very detailed and it is divided into many categories such as Non-Developmental Expenditure and Developmental Expenditure. Non-Developmental Expenditure includes items such as defense, police, food subsidies and famine relief.

The Developmental Expenditure includes items such as education, railways, civil aviation, and agriculture. This was all collected at current prices and was converted to 1993 prices using a GDP deflator from WDI.

As, the government spending data was extremely detailed it had to be sorted into broad categories. The categories chosen and their components are described in the table below. Furthermore, certain components had to be eliminated; mainly transfers as these only increase consumption and do not necessarily affect productivity.

The remaining portions of government spending were put together into a single category "Other".

Figure 1 provided in the Introduction gives the breakdown of the different categories of government spending. The most notable changes over the 42-year period being the decrease in infrastructure spending along with the corresponding increases in education and agriculture spending. At the same time the share of government spending in GDP has only modestly increased since 1961, registering a large increase during the 1980s but coming down to around 17% at the end of the 2002 fiscal year. Additional graphs in Appendix A show government spending as a percentage of GDP and the categories of spending divided by other that are used in the regressions that follow.

Table 4.2
An Explanation of Government Spending Categories

Government Spending Category	*Category Components*
Defense	Defense
	Border Roads
Infrastructure	Power Projects
	Transport & Communications
	Public Works
	Railways
	Posts & Telecommunications
	Housing
	Urban Development
	Broadcasting
	Economic Services
	Industry & Minerals
Agriculture	Crop Husbandry
	Soil & Water Conservation
	Animal Husbandry
	Dairy Development
	Food Storage
	Minor Irrigation
	Major Irrigation
Health	Public Health, Water Supply & Sanitation
Education	Education
Research	Scientific Services
Other	Tax Collection Charges
	Currency, Coinage & Mint
	Police
	External Affairs
	Organs of State
	Technical & Economic Cooperation
	Family Welfare
	Compensation & Assignment to Local Bodies
Transfers	Interest Payments
	Pensions
	Relief for Natural Calamities
	Food Subsidies
	Social Security & Welfare
	Fertilizer Subsidy
	Loans & Advances

5. The Composition of Government Spending & Aggregate Output: Level Effects

Table 5.1 presents the estimates of the parameters in equation (7). These were calculated using OLS and robust standard errors through the statistical program STATA. The regressions reported in columns (1) and (2) represent the entire Indian economy, using data from all industries and labor data from the Total Economy Database. When interpreting the results, figure 3 in Appendix A will help in understanding the values $\frac{g_i}{g_m}$ assumes.

Regression (1) includes all six government spending categories and a factor indicating the size of government spending in the economy (G/Y). A figure of the residuals is provided in Appendix E, though the high R^2 demonstrates that there is a very close fit between the fitted and the actual points. Since time series data was used, a high R^2 is expected and it is not a useful diagnostic for this regression. Most of the coefficients in Regression (1) were significant at the 5% level except for ln(Defense/Other) and ln(Research/Other). An F-test was conducted to estimate whether the two variables were jointly significant. They were not as the F-statistic reported was .08, with a corresponding p-value of .9215. It was decided that the two variables could be dropped from the regression. In order to do so, the "other" category was reformulated to include defense and research.

Column (2) shows the results of the regression using the newly formulated "other" category. While none of the signs changed on moving defense and research to the "other" category and there is only a very small change in the magnitudes; the coefficients

Table 5.1
Dependent Variable: ln(GDP/Worker)[4]

	(1)	*(2)*
Year	.0212*	.0225*
	(0.000)	(0.000)
ln(G/GDP)	-.2732*	-.3197*
	(0.002)	(0.000)
ln(Defense/Other)	.015	
	(0.794)	
ln(Infrastructure/Other)	.0834**	.0822**
	(0.045)	(0.039)
ln(Agriculture/Other)	-.0634**	-.0693**
	(0.047)	(0.022)
ln(Health/Other)	-.3662*	-.3467*
	(0.000)	(0.000)
ln(Education/Other)	.2253*	.1779**
	(0.008)	(0.031)
ln(Research/Other)	-.0174	
	(0.712)	
ln(Capital/Worker)	.4732*	.4533*
	(.002)	(0.001)
Intercept	-38.2644*	-40.7067*
	(0.000)	(0.000)
R^2	.9941	.9938

[4] Figures reported in brackets are p-values.
* Significantly different from zero at the 1% level
** Significantly different from zero at the 5% level

did become more significant. In column (2) all the coefficients are significant at the 5% level and it is referred to as the "best" regression in the sections ahead. All the further analysis builds from the results in column (2) of Table 5.1.

The results in column (2) seem sound as the growth rate of GDP per capita for the 42-year period is estimated to be 2.12%. This number was compared to the average growth rate over the same period, which was 2.49%. The estimate is similar enough to the average growth rate, indicating that the regression accurately captures the component of output that can be alluded to time. Similarly, the coefficient for ln(Capital/Worker), which can be interpreted as the capital share in output falls between 0 and 1. This is essential to prove that the model can be used for the Indian economy as one of the primary assumptions was constant returns to scale. Moreover, the estimate of .45 is reasonable for a developing country. Batista & Potin (2005) calculated the marginal product of capital for several countries, and while they did not include India in their dataset, the average marginal product of capital of the developing countries in their dataset was .57.

The coefficient on ln(G/Y) can easily be interpreted as the elasticity of output with respect to the size of the government. The elasticity is estimated at -.32 (rounded from -.3197) and it is significant at the 1% level. This means that a 1% increase in the size of government, keeping the component categories' shares constant, leads to a .32% decrease in output per worker. As such, when G/Y is increased by 1% from its average level of around 17% to 17.17%, output per worker decreases by .32%. On the other hand, if G/Y is increased from 17% to 18%, which represents a 5.88% increase in the ratio, output per worker would decrease by 1.88%.

The interpretation of the categories of government spending is a little less intuitive as they are represented as shares of other spending, not overall spending, i.e. as $\frac{g_i}{g_m}$, not $\frac{g_i}{G}$. For example, the coefficient on ln(Infrastrucure/Other) indicates that a 1% increase in Infrastructure/Other leads to a .08% increase in output. Increasing the ratio of infrastructure spending to other spending is to increase the relative emphasis on infrastructure spending as opposed to the remaining categories of government spending (agriculture, health and education). This can be achieved by increasing infrastructure, decreasing other spending and consequently decreasing all the remaining categories so that total spending remains constant and the ratio of all the remaining categories to other spending (agriculture/other, health/other and education/other) remain constant. Thus, a 1% increase in Infrastructure/Other should not be interpreted as 1% increase in infrastructure spending.

The coefficients on Agriculture/Other, Health/Other and Education/Other should also be interpreted as described above. The results point out that the two most important government spending categories are health and education, as they have the largest coefficients. The coefficient on ln(Health/Other) is -.35, which means that increasing the emphasis on Health over other categories of spending depresses output. Education spending, on the other hand, has a positive impact on output with a coefficient of .18. Lastly, increasing the emphasis on agricultural spending, decreases output by a small quantity. A 1% increase in Agriculture/Other decreases output per worker by .07%.

The findings summarized in Table 5.1 indicate that the size of the government is inversely related to GDP/worker. This is in keeping with the findings of most other studies. A large government is said to give rise to inefficiencies in the working of the economy. Barro's estimate of this number for a panel of countries, including India was -.136 while this paper's is -.32. This difference is not a cause of concern because Barro's findings used many countries including OECD ones and the focus here is only on a single country. Barro attributes this negative relationship to the associated taxation that might be needed to finance large amounts of government spending. Proportional taxation can affect output by decreasing the marginal product of labor and capital. At 17% of GDP, the Indian government is fairly large for a developing country. This negative effect is compounded by high levels of bureaucracy and corruption associated with a large government that is likely to depress overall output.

For the economy, it was found that spending on defense and research did not have impacts on output that were statistically significant. This was not a surprising finding for the research variable as it was one that did not vary much over time and was also much smaller in comparison to the other government spending categories. On the other hand, defense spending was expected to have a negative impact on output. Papers such as Devarajan (1993) and Baffes & Shah (1998) found defense spending to diminish output, especially in developing countries. Around 15% of India's government spending is on defense, a large percentage for a developing country and for a long time it was the second largest component of government expenditures. Thus, it is still troubling that this large component does not have a significant impact on output.

Infrastructure spending is found to have a small positive effect on output. Though its impact is modest, it does not differ from what was found by Baffes & Shah, and Aschauer. infrastructure spending affects Total Factor Productivity by increasing the level of technology or increasing the ability to implement technology. Infrastructure spending in India is spread over a wide range of goods and services, from power projects and housing, to railways and telecommunications. All of these investments are important for the rapid industrialization of the country and to improve the efficiency of the economy. These are also exactly the kind of factors that can raise the Total Factor Productivity of the economy.

The agriculture results were unique as there were no papers to compare them to. None of the papers examined in the literature review included agricultural spending in their analyses. Agriculture spending was found to have a small negative effect on output. While it is not obvious why this should be so, one possible explanation might be that there is a high opportunity cost of increasing agriculture spending. Since increasing agriculture involves decreasing other categories like education and infrastructure so as to keep total spending constant, the coefficient on agriculture spending might actually represent that effect. Of course, this explanation can be applied to all the spending categories. In the case of agriculture, the findings simply indicate that it is relatively less important than the other categories like infrastructure and education.

The findings concerning Health spending are in line with existing literature on the subject. Health spending has been commonly found to cause decreases in output. This finding is not intuitive, as one would imagine that health spending would help increase output by improving the level of human capital. Devarajan (1993) who finds a similar result with Health spending provides one explanation for why this might not be true. Their paper states that the model “may be capturing ... the fact that public expenditures in these sectors do not necessarily lead to increases in the stock of human and physical capital, so that the connection with economic growth is severed”. This explanation questions the efficiency and effectiveness of the government to provide health services. Another possible explanation for the negative impact of health spending on output is that it may be a response to public health crises, which would lead to reduced output.

Moreover, investments in human capital probably only yield returns after a certain number of years. The model used in this paper does not account for that lag and instead tries to link spending in year *t* with output in year *t*. However, ideally, spending in year *t* has an impact on the output of future years. At the same time, perhaps health spending can be found to be more productive if it is increased in proportion with other spending. The argument for introducing a lag can also be applied to education spending. The results indicate that a 1% increase in Education/Other leads to a .18% increase in output. This makes education spending the variable with the largest positive impact on GDP. This is a significant finding and matches the findings of the papers discussed in the literature review. Almost all papers discussed found that education spending was the only variable to positively impact output. This can be understood as an investment in human capital and as education expenditure is largely spent on public schooling it can improve the productivity of labor.

Table 5.2 compares this paper's results to the results discussed in the literature review. In most cases the findings seem to match those in the literature and discrepancies can be attributed to differences in models and sample countries.

Table 5.2
Summary Comparison of Results to Literature[5]

			Spending Category				
Paper	*G/GDP*	*Defense*	*Infrastructure*	*Agriculture*	*Health*	*Education*	*Research*
Parekh (2007)	-	~	+	-	-	+	~
Landau (1983)	-	N/A	N/A	N/A	N/A	+	N/A
Landau (1986)	N/A	~	N/A	N/A	N/A	+	N/A
Aschauer (1989)	N/A	N/A	+	N/A	N/A	N/A	N/A
Devarajan (1993)	N/A	-	N/A	N/A	-	-	N/A
Evans & Karas (1994)	N/A	N/A	~	N/A	~	+	N/A
Baffes & Shah (1998)	N/A	-	+	N/A	+	+	N/A
Hansson & Henrekson (1994)	N/A	N/A	N/A	N/A	N/A	+	N/A
Wyatt (2005)	-	~	N/A	N/A	~	-	N/A

[5] ~ Indicates that the coefficient estimates was not statistically significant.
N/A Indicates that the variable was not included in the regression.

5.1 Counterfactual Analysis

In order to provide additional insight into these findings, a counterfactual analysis was conducted. This analysis involved examining the trends in $\frac{g_i}{g_m}$ over the time period, and extending certain trends to produce alternative values of $\frac{g_i}{g_m}$. These values of $\frac{g_i}{g_m}$ were then plugged into the regression results to construct counterfactual values for Output/Worker. Finally, the counterfactual values were compared to the fitted values of Output/Worker using the actual data. This analysis was conducted for infrastructure, agriculture and education spending as the other categories did not any significant change in trend over the sample period.

5.1.1 Infrastructure Counterfactual

Figure 5.1 shows Infrastructure/Other over the time period studied. One noticeable trend is the steady increase in Infrastructure/Other from 1967 to 1982. The yellow line was created by calculating the average growth rate of Infrastructure/Other between 1967 and 1982 and then projecting the variable further using that growth rate from 1983 to 2002. Thus, between 1983 and 2002, the yellow line shows Infrastructure/Other growing at a rate of 4.32%. The counterfactual (Figure 5.2) was calculated using these results and was plotted against the original fitted values. The counterfactual measures the level of output per worker if Infrastructure/Other had continued to grow at 4.32% a year. The graph 5.2 shows that the level of output per worker would have been greater had that been the case. Moreover, the average growth rate of output per worker between 1983 and 2002 would have been 4.1% as compared to

3.5%. This effect would have arisen solely from the continued growth in infrastructure spending.

5.1.2 Education Counterfactual

A similar analysis was conducted for education spending as well. Figure 5.3 shows the trends in Education/Other (purple line) over time. The variable is seen to be growing gradually at a rate of 1.6% from 1961 to 1988, at which point it jumps up, and then continues to grow. The counterfactual in this case examines what would have happened to output if Education/Other had not jumped, and had continued to grow at 1.6% between 1989 and 2002 instead of the actual rate of 2.89%. Figure 5.4 illustrates the effect of this possibility on output per worker. The green line, which represents the projected output per worker, is slightly lower than the fitted line. Thus, the impact of the one time increase in education spending is seen to have a small effect on output. The growth rate of the fitted line between 1989 and 2002 was 3.8% while that of the projected line was 3.65% over the same period. Though this is a small effect, it illustrates the kind of impact education spending can have on output.

5.1.*3 Agriculture Counterfactual*

Figures 5.5 and 5.6 show how changes in the emphasis on agriculture spending can affect output per worker. In this case, Agriculture/Other is growing at a steady rate of 1% from 1961 to 1992 and then starts to decline. The projected line in Figure 5.5 shows Agriculture/Other continuing to grow at 1%. This would lead to a slightly lower level of output as is seen in Figure 5.6. The diagram puts the results into perspective by showing the magnitude of the increase needed in Agriculture/Other to produce a small decrease in Output/Worker. The average growth rate of output per worker between 1993 and 2002 for the fitted line was 4.3% and that of the projected line was 3.4%.

Figure 5.1

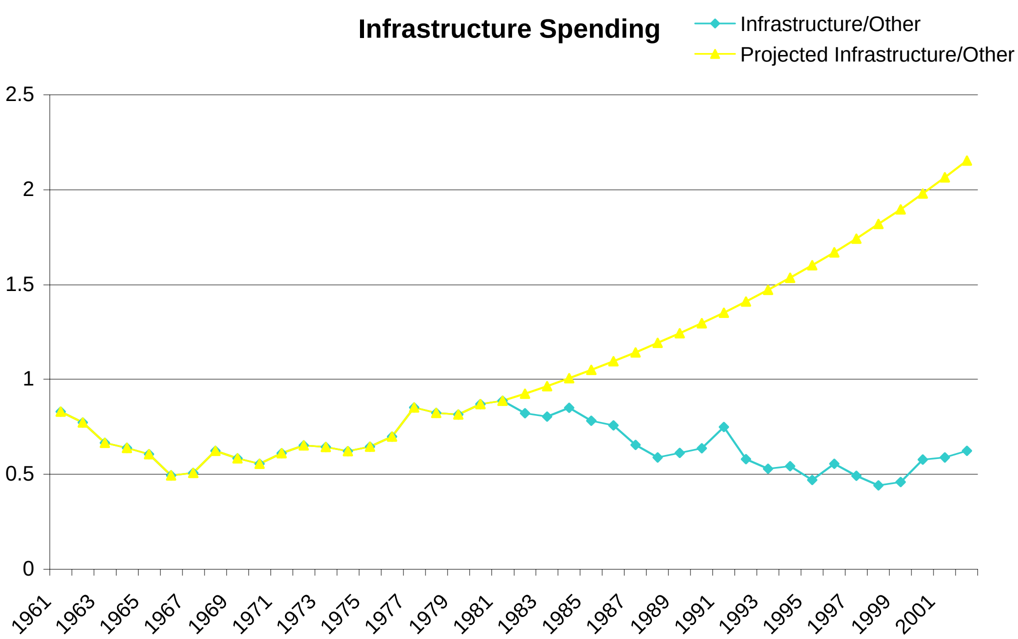


Figure 5.2

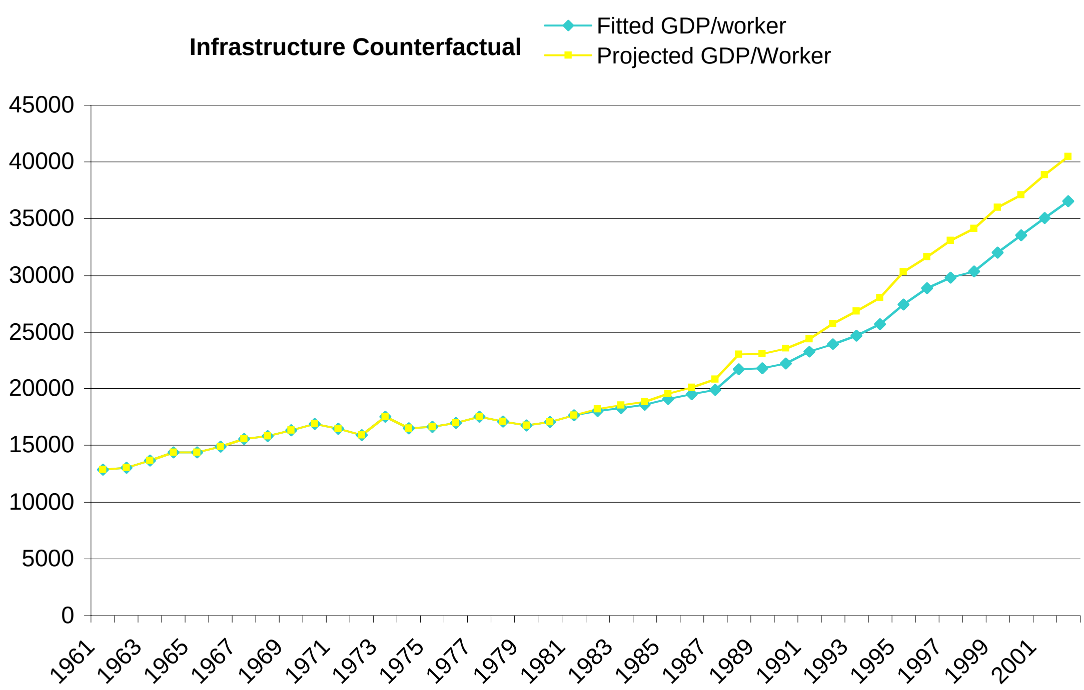


Figure 5.3

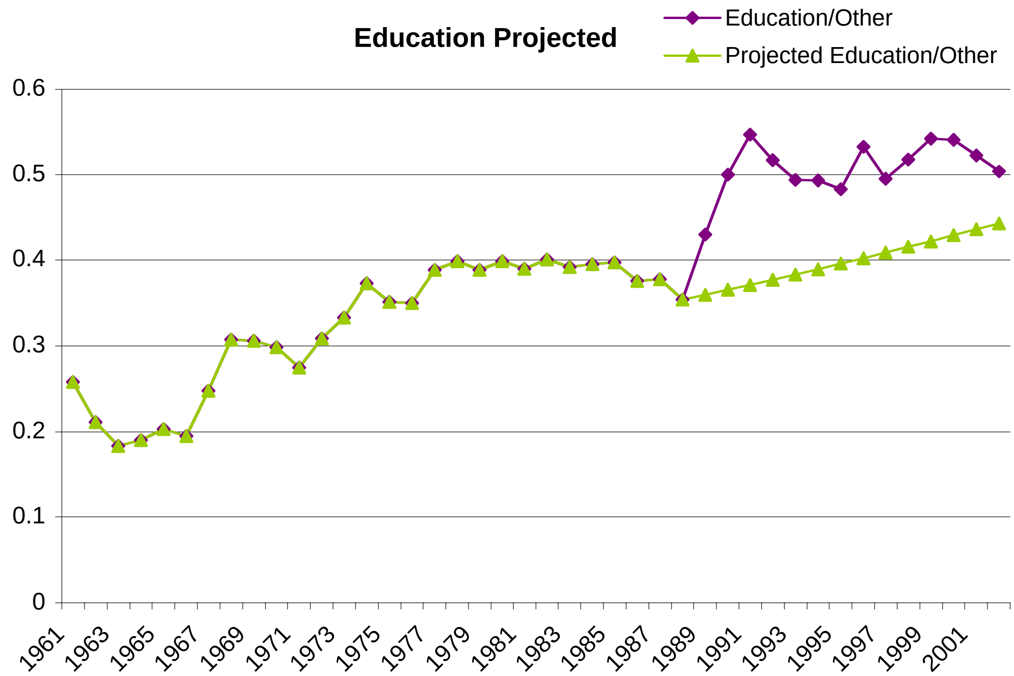


Figure 2.4

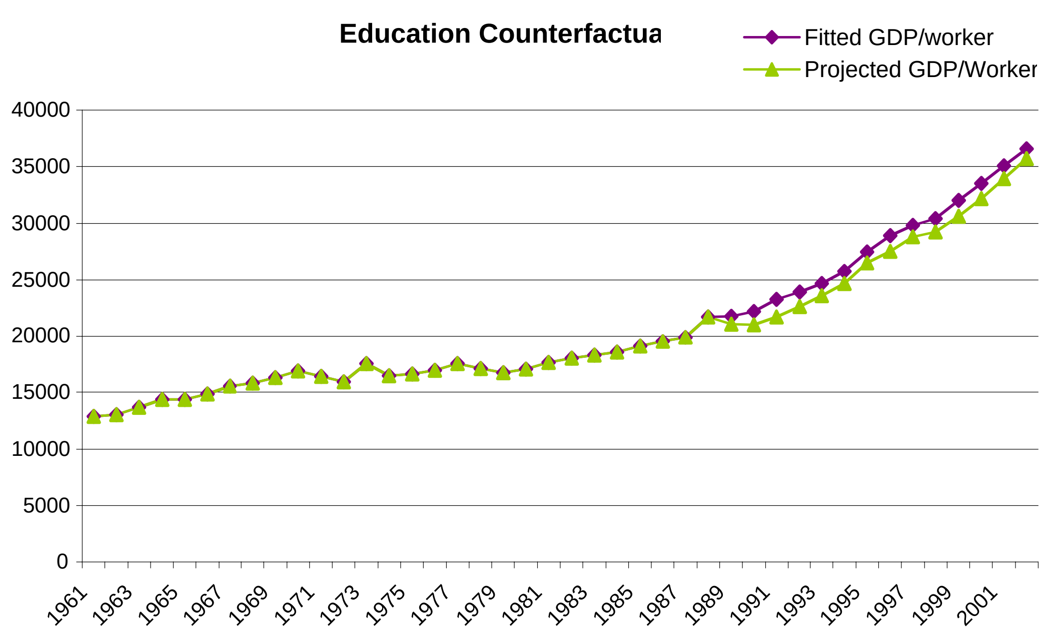


Figure 5.5

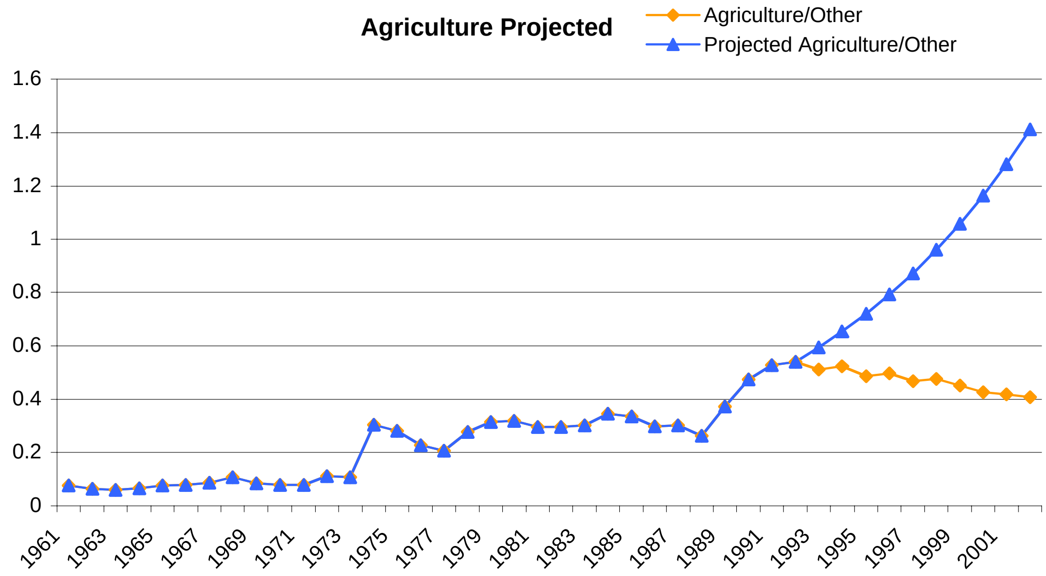
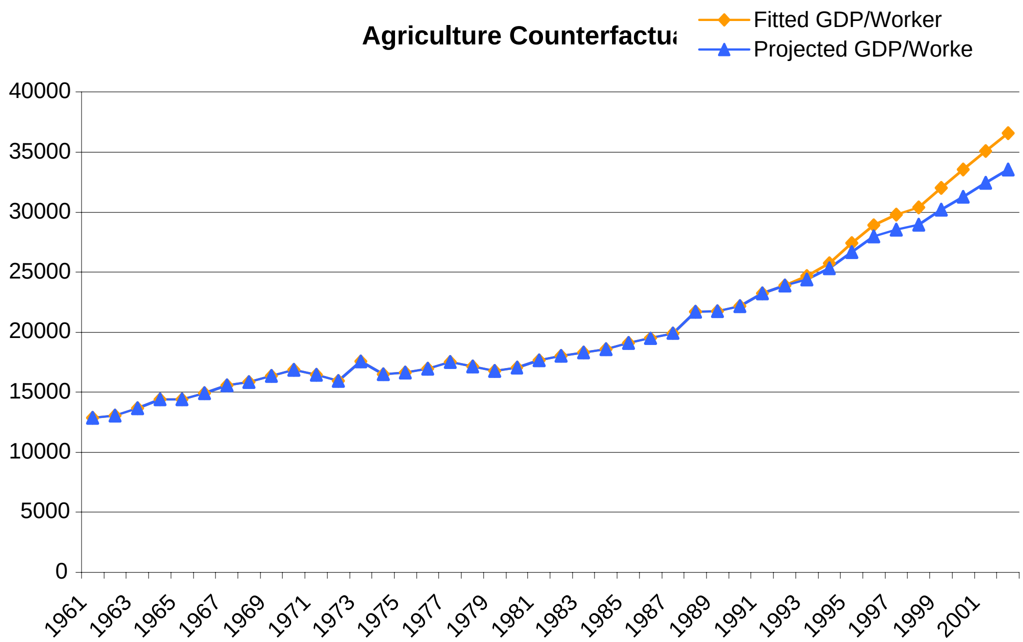


Figure 5.6



6. Industry Results

This section of the paper examines the role of government spending in different industries that form a part of the Indian Economy. This was done to provide a deeper level analysis that recognizes that government spending could work through different mechanisms depending on the industry. Thus, while infrastructure spending may have a positive impact on manufacturing output; it might have a smaller or even negative impact on output in other sectors. The results for aggregate output do not provide this kind of information that can be extremely valuable to a government when it is trying to choose the industries it wants to promote.

This analysis was conducted using a model similar to the one used for the Level Regressions in the previous section. The same equation was estimated for each of the industries using industry level data of output, capital and labor. The modified version of the equation is presented below:

$$\ln y_{jt} = \alpha_{j0} + \gamma_j t + \theta_j \ln g_t + \sum_{i=1}^{m-1} \alpha_{ij} \ln\left(\frac{g_{it}}{g_{mt}}\right) + \beta_j \ln k_{jt} + \varepsilon_{jt} \quad (8)$$

The equation was estimated for eight groups of industries: Agriculture, Forestry & Fishing, Mining & Quarrying, Manufacturing, Electricity, Gas & Water Supply, Construction, Trade, Hotels & Restaurants, Transport, Storage & Communication, and Community, Social & Personal Services. The only industry not included was Finance, Real Estate & Banking as continuous labor data was not available for it.

A summary of the results has been provided on the following page and the full detailed regression results for each industry are in the Appendix F. Table 6.1 shows the signs of the coefficients on the government spending variables for each industry and

Table 6.1

Summary of Industry Results[6]

		Industry							
		G/Y	*Defense*	*Infrastructure*	*Agriculture*	*Health*	*Education*	*Research*	*Capital*
Variable	*Economy*	-	N/A	+	-	-	+	N/A	
	Agriculture	-*	N/A	N/A	-*	-*	N/A	+*	.7297*
	Manufacturing	-*	+*	N/A	-*	-*	N/A	N/A	-.0643=
	Mining	-*	+*	-*	-*	N/A	N/A	N/A	.1678*
	Electricity	-*	N/A	N/A	-*	-*	+*	N/A	.5658*
	Communication	-*	N/A	+*	N/A	-*	N/A	N/A	.4497*
	Construction	+=	N/A	N/A	N/A	-*	+*	-=	.6504*
	Trade	-*	N/A	+*	N/A	-*	N/A	N/A	.6049*
	Services	-*	N/A	+*	-*	-*	N/A	N/A	-.1046=

[6] * Indicates that the coefficient was statistically significant at the 10% level.
= Indicates that the coefficient was not statistically significant at the 10% level.
N/A Indicates that the variable was not included in the regression.

indicates whether the coefficient was significant at the 10% level. In all cases, the "best" regressions from Appendix F were used. The "N/A" refers to those variables that were not individually or jointly significant and were dropped to achieve the "best" result. At the 10% significance level, the coefficients on 28 of 30 government spending variables and 6 of 8 ln(Capital/Worker) variables were significant. At the 5% level, 23 of 30 government spending variables had significant coefficients and there was no impact on the number of significant capital coefficients.

Thus, when compared to the results for aggregate output, the sectoral results were less robust. This was probably because of the model's limitations that did not extend well to certain industries but could also be alluded to the fact that the labor data for the sectors was projected. The weakest results were obtained from the Manufacturing and Service sector where the coefficients on the capital variable were negative and statistically insignificant. The model used assumed constant returns to scale, which may not adequately characterize the Manufacturing and Services industries. The results for the Construction were also weak as even in the best regression, only two of the four government spending variables were significant at the 10% level and only one was significant at the 5% level. This shows that the broad assumptions made for the economy do not always translate well to industries. However, the results are still more robust than Wyatt's, who was only able to get significant results for three industries.

The results revealed unique features about the industries and the coefficients did not always match the aggregate results. Of particular note, was the finding that defense spending had a positive impact on Mining output though it has no impact on output for any of the other industries or the economy. The coefficient on defense spending was

.3595, implying that a 1% increase in Defense/Other could lead to a .35% increase in Output/Worker. This finding does make economic sense, as defense spending would stimulate industrial output that uses inputs that comes from mining such as metals. Agriculture and infrastructure were also more important for the Mining industry than for the economy as a whole; their coefficients were roughly three times larger. The coefficient on infrastructure had a negative sign, while it has a positive coefficient in the economy. On the other hand, capital share was very small at only .1678.

Research spending, which was also not significant for the economy, had a positive and significant effect on Agricultural output. Alarmingly, the coefficient on agriculture spending was negative at -.0596. This is worrisome as, one would expect the government's targeted expenditure on this particular industry would help boost the industry. The coefficient on Health spending is less negative than it is for the economy. As agricultural work is largely manual labor, it follows that health spending should be more beneficial than it is for the economy, though it is still negative.

The results for the Electricity sector reflect its more industrial nature. Output in this sector was less affected by the size of the government than the economy. The coefficient on ln(G/Y) was only -.1657 for the Electricity sector as compared to -.3197 for the economy. At the same time, health and education spending had much larger coefficients, though health still depressed output and education boosted it. Education spending also had a very large impact on Construction output; the coefficient was .7292. A remarkable finding was the effect of health spending on the output of the Trade sector, where it was found that that a 1% increase in Health/Other could lead to a 1.57% decrease in Output/Worker. This was the only case where the elasticity of a spending category exceeded one. Infrastructure was found to be very beneficial for both Trade and Communications. This too, makes economic sense as a large component of infrastructure spending is on roads, railways and power projects that are needed for better trade and communication.

The results here certainly provide some insight on the effect of government spending categories on different industries. However, these findings could be further developed by creating new methodologies for industries such as Manufacturing, Services and Construction that were not be accurately modeled in this paper.

7. 1991 Dummy Results

One of the goals for this paper was to determine the effect of the Indian government's economic reforms following 1991. An examination of the composition of government spending does not show any major changes between the pre and post reform periods (see figure 1). There is a small increase in the share of infrastructure spending and agriculture spending, though these changes do form a part of larger trends seen in the data. The changes may not be so obvious because the process of reform began in the 1980s and only the largest changes in macroeconomic policy occurred in 1991 when the country experienced a Balance of Payments crisis. As for the relative importance of government spending categories (the $\frac{g_i}{g_m}$ variables), they all see a small surge in 1992 and then continue with the pre-reform trend. However, it is still important to assess whether there was any change in productivity in the post reform period since there were major macroeconomic policy changes that could have affected the qualitative aspects of spending rather than the quantitative ones.

In order to capture the effects of reform, a dummy variable (D) was created into that was zero for the pre-reform period (1961-90) and one for the post-reform period (1991-2002). An interaction effect was introduced between D and each government spending variable. As such, the coefficient on the interaction term measures the change in the productivity of spending for a year, given that it is a post-reform year. Equation (7) is modified to the following:

$$\ln y_t = \alpha_0 + \gamma t + \theta g_t + \sum_{i=1}^{m-1} \alpha_i \ln\left(\frac{g_{it}}{g_{mt}}\right) + \eta D_t g_t + \sum_{i=1}^{m-1} \upsilon_i D_t \ln\left(\frac{g_{it}}{g_{mt}}\right) + \beta \ln k_t + \varepsilon_t (9)$$

Equation 9 was estimated using OLS and the results are presented in Table 7.1.

Table 7.1
Dependent Variable: ln(Output/Worker)[7]

Independent Variable	*(1)*	*(2)*
Year	.0212*	.0216*
	(0.000)	(0.000)
ln(G/Y)	-.1292	-.197*
	(0.257)	(0.008)
ln(Infrastructure/Other)	.1211***	.1664*
	(0.087)	(0.000)
ln(Agriculture/Other)	-.0975*	-.0931*
	(0.000)	(0.000)
ln(Health/Other)	-.4996*	-.5169*
	(0.000)	(0.000)
ln(Education/Other)	.4256*	.3783*
	(0.001)	(0.000)
D*ln(G/Y)	-.2335*	-.188*
	(0.003)	(0.000)
D*ln(Infrastructure/Other)	-.2022*	-.2185*
	(0.000)	(0.000)
D*ln(Agriculture/Other)	-.2207*	
	(0.294)	
D*ln(Health/Other)	.4585**	.2555*
	(0.017)	(0.000)
D*ln(Education/Other)	-.1824	
	(0.275)	
ln(Capital/Worker)	.2902**	.4132*
	(0.029)	(0.000)
Intercept	-36.1628*	-38.4702*
	(0.000)	(0.000)
R^2	.9964	.9962

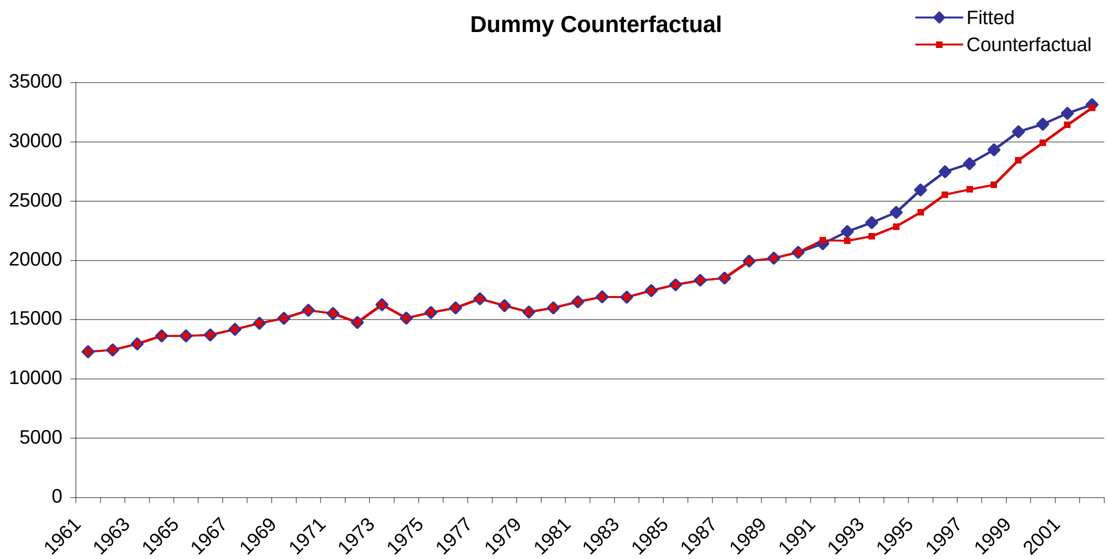
[7] Numbers in parentheses are p-values.
- Indicates that the coefficient was statistically significant at the 1% level.

** Indicates that the coefficient was statistically significant at the 5% level.
*** Indicates that the coefficient was statistically significant at the 10% level.

The regression was first run including all the interaction effects between the government spending variables and the dummy. This yielded column (1) of Table 7.1. Defense and research were not included in the regressions, as they were not found to be significant over the entire period. The coefficients on ln(G/Y) and the dummy variables for agriculture and education were all found to be insignificant; and an F-test of joint significance reported a p-value of .43. As such, those variables were eliminated and another regression was run which gave the results reported in column (2) of Table 7.2. The results thus obtained were extremely robust and the coefficient on ln(G/Y) became significant. Furthermore, the share of capital changed from .29 in column (1) to .41 in column (2), which is closer to the estimate in Table 5.1.

The results show that in the post-reform period, increasing the size of government (G/Y) had a larger negative impact than the same action in the pre-reform period. In the post-reform period, a 1% increase in the size of government led to a .39% decrease in output per worker. One would imagine that the economic reforms made the government more productive, but this was not seen in the results. Similarly, infrastructure spending is also less productive in the post-reform period. A 1% increase in Infrastructure/Other leads to .05% decrease in output per worker in the post-reform period but a .16% *increase* in the pre-reform period. However, health spending was found to be much less productive in the pre-reform period than in the post-reform period. In the pre-reform period the coefficient on Health/Other is -.52 but in the post-reform period it is only .26. This represents a 50% decrease in the coefficient. The inclusion of the dummy variable also affected the coefficients of agriculture and education spending. Most notably, the coefficient on education spending increased from .18 in Table 5.1 to .37.

Figure 7.1



To further illustrate the difference between the pre and post reform periods, a counterfactual analysis was conducted. In this analysis, the estimates obtained in column (2) were used to project values for output if economic reforms had not occurred. Thus, the estimates are used to calculate values of output per worker, but it is assumed that the dummy is 0 for all years. The figure provided above plots the fitted values of output per worker for both scenarios; one where the dummy variables are included and one where they are ignored. The figure shows that despite the negative coefficients on the dummies for G/Y and infrastructure spending, output per worker was higher for the counterfactual results than the fitted results. This is probably because the coefficient on health spending was positive and its share is much larger than that of infrastructure. Nevertheless, the difference between the output estimates disappears by 2002. The average growth rates between 1991 and 2002 were also computed for both series. The average growth rate of the counterfactual was 3.95% and that of the fitted was 4.02%, indicating there was not much difference in growth between the two series.

8. Growth Results

The last analysis conducted tests the hypothesis that government spending can directly affect the growth rate of output. This could be possible if government spending increased the growth rate of Total Factor Productivity. This would allow it to affect the growth rate of output and the level of output. The production function used in the earlier section is modified to measure that effect. This is achieved by including an interaction effect between government spending and time. Such a term captures those effects that occur from time and spending increasing jointly. The production function would now look like this:

$$Y_t = e^{\alpha_0 + \gamma t + \varepsilon_t} g_t^{\theta + \mu t} g_{1t}^{\alpha_1} g_{2t}^{\alpha_2} \ldots g_{mt}^{\alpha_m} K_t^{\beta} L_t^{1-\beta} \quad (10).$$

After a series of steps, the following equation was obtained:

$$\ln y_t = \alpha_0 + \gamma t + \beta \ln k_t + \mu t \ln g_t + \theta \ln g_t + \sum_{i=1}^{m-1} \alpha_i \ln\left(\frac{g_{it}}{g_{mt}}\right) + \varepsilon_t \quad (11).$$

Equation 11 was estimated and the results are reported in the table on the following page. Once again, the variables from the "best" regression in Table 5.1 were used, and so defense and research spending were not included in this regression. The inclusion of the Year*ln(G/Y) variable did not have a large effect on the coefficients of the other government spending variables.

Though the coefficients on ln(G/Y) and Year*ln(G/Y) are not significant at the 10% level, the coefficients are jointly significant at the 1% level with a p-value of 0.000. As such, they are not dropped out from the regression and their impact is discussed. Since the coefficient on Year*ln(G/Y) is very small, it does not affect the growth rate that much. However, it does show that government spending has a negative impact on the

Table 8.1[8]
Dependent Variable: ln(Output/Worker)

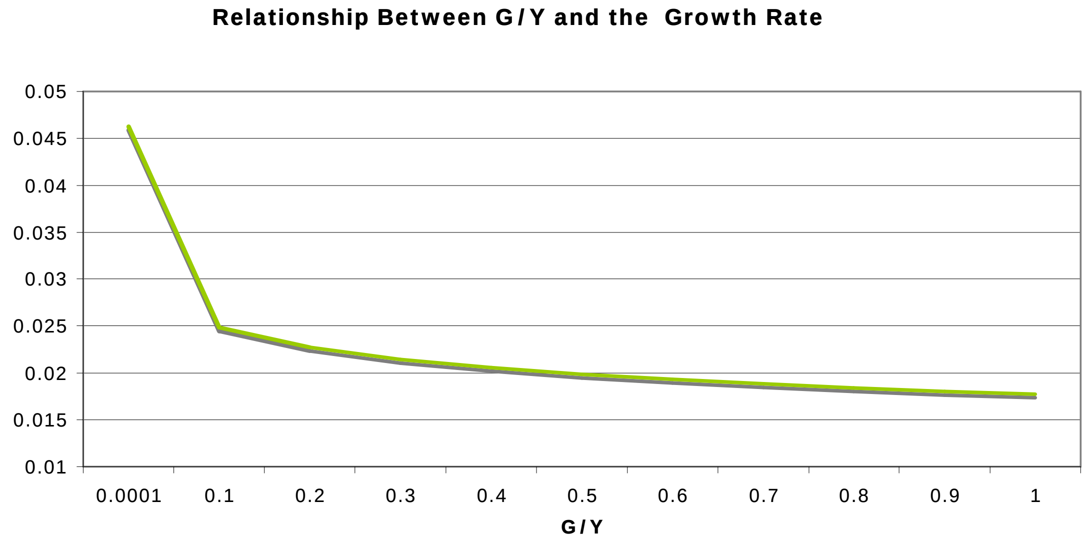
Independent Variable	*(1)*
Year	0.0177**
	(0.052)
ln(G/Y)	5.7234
	(0.549)
Year*ln(G/Y)	-.0031
	(0.526)
ln(Infrastructure/Other)	.0806**
	(0.046)
ln(Agriculture/Other)	-.076**
	(0.024)
ln(Health/Other)	-.351*
	(0.000)
ln(Education/Other)	.1913*
	(0.000)
ln(Capital/Worker)	.42*
	(0.005)
Intercept	-30.864***
	(0.083)
R^2	.9938

Table 8.2
Net Growth Rates

G/Y	0.01	0.1	0.17[9]	.25	1
Net Growth Rate	3.2%	2.48%	2.32%	2.2%	1.77%

[8] Numbers in parentheses are p-values.
.* Indicates that the coefficient is statistically significant at the 1% level.
** Indicates that the coefficient is statistically significant at the 5% level.
*** Indicates that the coefficient is statistically significant at the 10% level.
[9] This is the average size of the government in India between 1961 and 2002.

Figure 8.2



growth rate. These findings match Barro's who studied the determinants of economic growth and found that a 1% increase in the size of government decreased the growth rate by .13%. If government spending in India had been only 1% of GDP, the average growth rate over the period would have been 3.2%. The average level of spending for the Indian economy from 1961-2002 was 17% and this corresponds to a growth rate of 2.32%.

The figure above illustrates the relationship between G/Y and the growth rate for India. The graph shows how at low levels of G/Y, small increases in spending can have a large impact on the growth rate, but at higher levels the same increase would have a much smaller effect. The method used here could be further developed by measuring the growth effects of the government spending categories. This would involve introducing interaction effects between time and each government spending category and estimating the following equation:

$$\ln y_t = \alpha_0 + \gamma t + \beta \ln k_t + \mu t \ln g_t + \theta \ln g_t + \sum_{i=1}^{m-1} \alpha_i \ln\left(\frac{g_{it}}{g_{mt}}\right) + \sum_{i=1}^{m-1} \lambda_i t \ln\left(\frac{g_{it}}{g_{mt}}\right) + \varepsilon_t \quad (12).$$

This was attempted for this paper but the regression did not produce strong results, probably due to the small size of the data set. Nevertheless, the results of that regression are included in Appendix G but are not discussed here.

9. Summary & Conclusion

The objective of this paper was to provide a comprehensive analysis of the role of government spending in the Indian economy. Specifically, the effects of different categories of government spending were measured and the model was extended to look at the effect of government spending on industrial output. The motivation behind these objectives was to provide an insight into the many mechanisms through which government spending can influence economic activity.

The results reported in this paper indicate that the size of government depresses aggregate economic output. Nevertheless, the relative importance of categories of spending differs across. Altering the importance of defense and research spending did not have a statistically significant impact on per capita output, and while increasing the emphasis on agriculture and health spending was found to decrease per capita output, prioritizing infrastructure and education spending had a positive effect on output. The results using industry level data were less robust than those reported using aggregate economic data. The size of the government remained inversely related with per capita output for all industries except construction. Research spending had a statistically significant effect on output per capita in the agriculture and construction industries, and defense had a significant, positive effect on mining output. Lastly, spending became less productive across all categories except health following 1991 and the growth effect of government spending was found to be negative.

The results of this study are fairly consistent with most research done on panels of countries. Unfortunately, the coefficients cannot be directly compared because of the differences in methodology and scope, but the role of government spending in India does not seem to be very different from its role in other countries. While government spending does have a negative effect on output that does not necessarily mean that it must be reduced or that certain functions must be privatized. It is essential to remember that the results of this paper are not normative judgments on the appropriate size of government. There is no way of knowing if the private sector would be better suited to provide the goods and services that the government does. It might be that those functions are inherently non-productive but the government should still try to make them as efficient as possible. At the same time, the negative coefficient on health spending does not mean that the government should cut health expenditures as it is trying to provide medical care and sanitation facilities that would not otherwise be provided.

However, this paper does give a good indication of the categories on which the government should try to focus. By increasing the component of education and infrastructure spending, the government could potentially increase output without necessarily increasing spending at all. The results from this paper can provide guidance to the Indian government to help it maximize its limited resources. The government can determine how to shuffle the budget allocation over different categories while keeping total spending constant using these results.

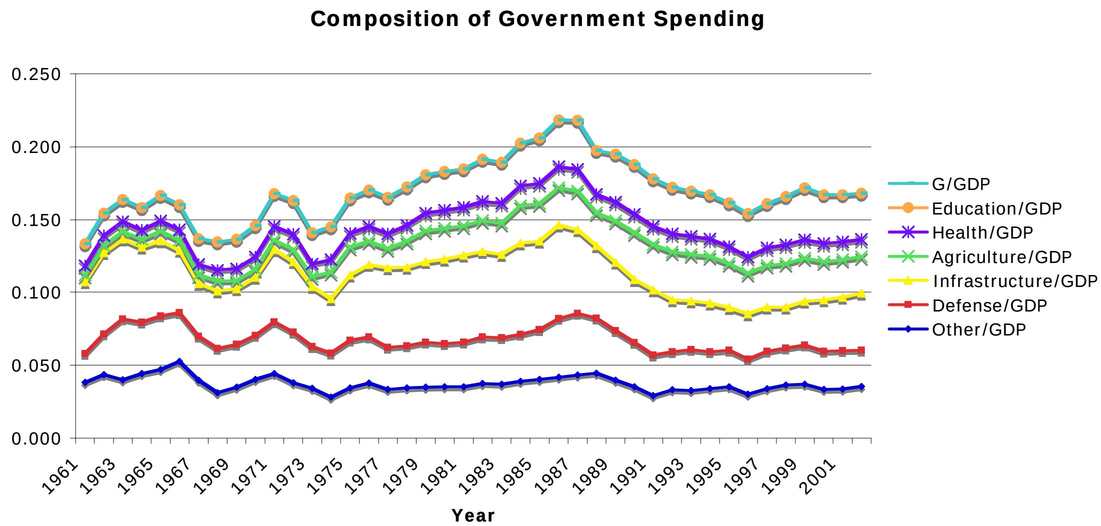
It is essential to point out some of the drawbacks of the model used in this paper. It was mentioned earlier that output might need to be lagged with past spending in order to accurately depict the causal mechanisms at work. Investments in factors like education, health and infrastructure do not produce results immediately and require many years to work through the system to produce measurable results. The data in this paper was not lagged, as it was important to keep the model as simple as possible. The second issue was data limitations that prevented the results from being as robust as desired. The number of observations was close to the minimum that could be used to run a regression and this would certainly have an effect on the quality of the results.

Both of the drawbacks mentioned above represent possible areas for improvement for future studies. Researchers could use state-level or quarterly data to produce stronger results. Furthermore, the model used in this paper could also be developed for other countries, enabling them to calculate the productivities of government spending for their economies. It is hoped that this paper provides a framework that is easy to adapt for others trying to examine the role of government spending in a single country.

Appendices

Appendix A: Some Government Spending Graphs

Figure A.1



The graph shows a plot of the different categories of government spending over time. The categories have been stacked so that the top-most line represents G/GDP. Research was not included because its values were too small to be graphed.

Figure A.2

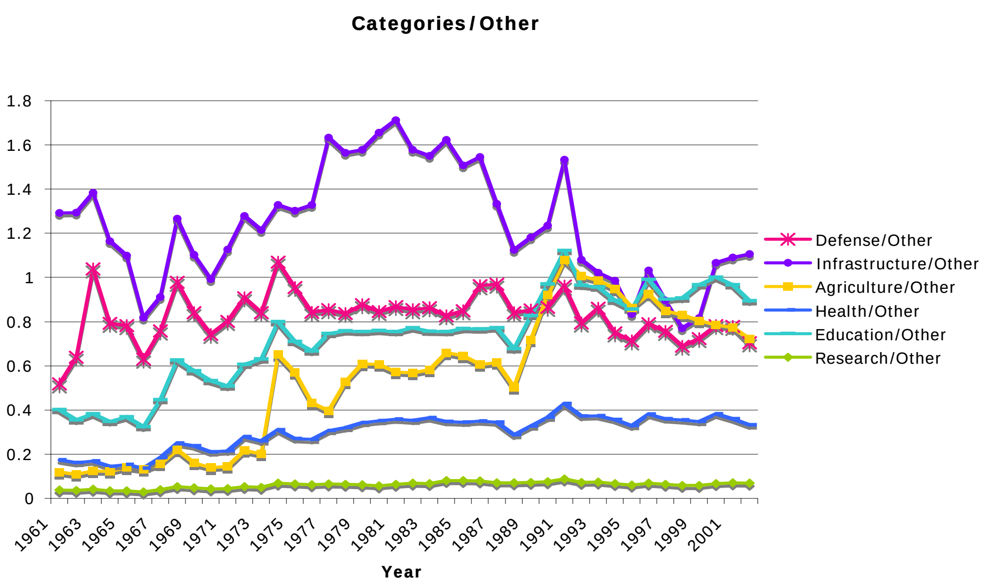
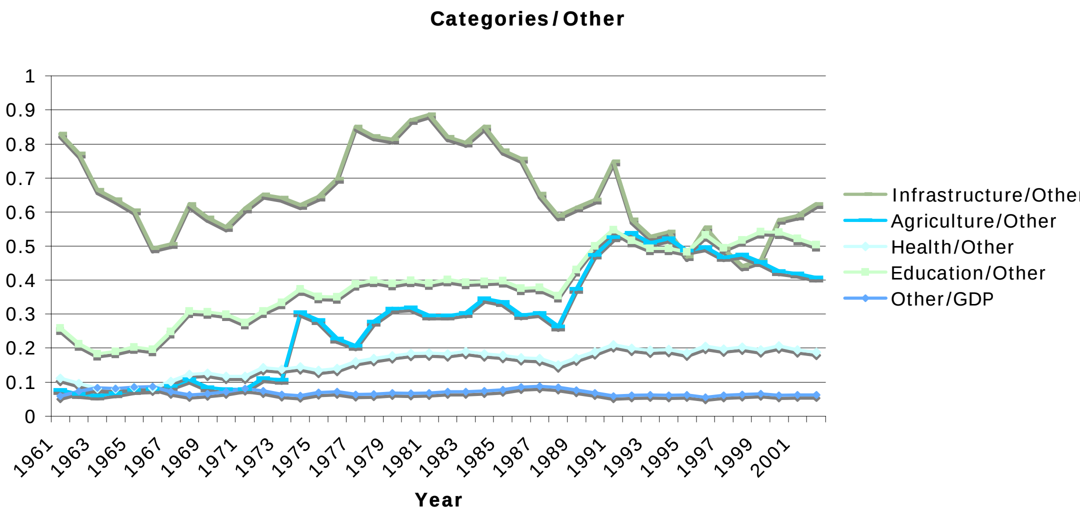
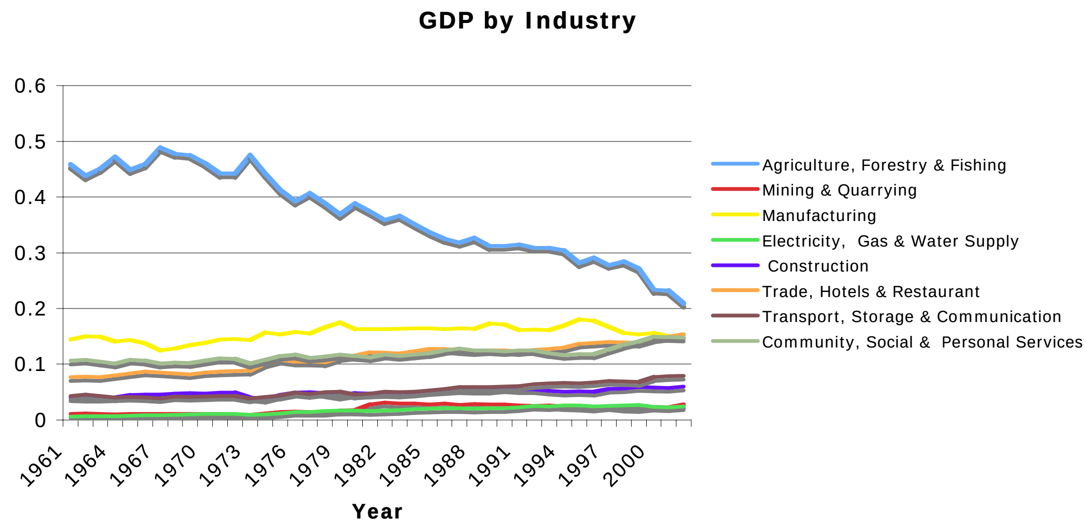


Figure A.3: Categories/Other after dropping Defense & Research



Appendix B: GDP by Industry Over Time

Figure B.1



Appendix C: Labor Data Estimation

The labor data was aggregated from three different sources. Indian Labour Yearbook, published by the Indian Government going back to 1960 provided data till 1991. The data between 1992 and 2001 was found on Indiastat.com which collected its data from the Indian Ministry of Labor. The third source was the Total Economy Database from the Groningen Growth & Development Center. Their data for 1960, 1971, 1981, 1991 and 1995 was calculated from decennial population censuses and employment from B. van Ark, *Estimates of Employment in India*. Movement for in-between years was interpolated and 1996-2004 extrapolated from 1995. While the data from the first two sources matched up, the third one was significantly different and its estimates were more realistic. Unfortunately, the Total Economy Database did not divide labor by industry while the government's data was categorized. Thus, I used the following system to calculate *realistic* estimates of industry wise data.

$\frac{L_j^*}{L^*} = \delta_j$, where * indicates that the data was calculated by the Indian Ministry of Labor, and *j* indicates the industry.

$\therefore L_j^e = \delta_j L^{TED}$, where L_j^e is the labor estimate for industry *j* and L^{TED} is the total labor number from the TED source.

Appendix D: Calculation of Government Spending Categories

Data was obtained from Indiastat.com (subscription required) which aggregates data from the Indian Government's Ministry of Finance. The data provided was extremely detailed, subdivided into various programs and categories. As such, I was able to eliminate the portion of government spending on transfers since transfers are not supposed to be productive. Thereafter, I combined certain programs to be able to reach broad categories such as Infrastructure, Health etc.

The following expenses were categorized in the following way:

Defense = Defense + Border Roads

Infrastructure = Railways + Posts & Telegraphs + Electricity Schemes + Industries & Economic Development + Export Promotion Schemes + Broadcasting + Community Development + Civil Aviation + Transport

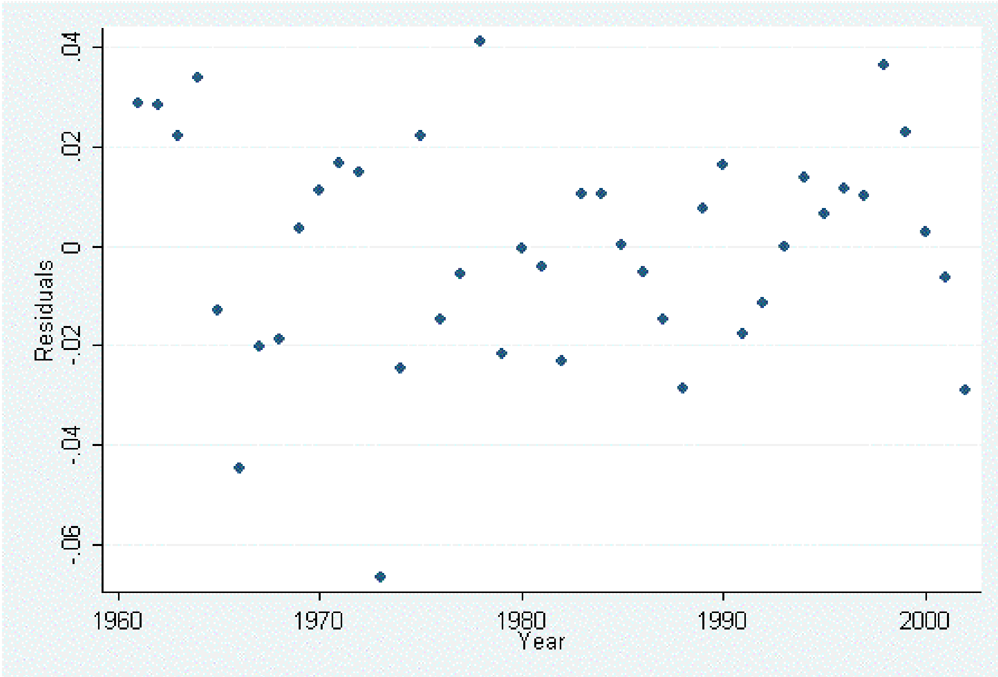
Health = Medical & Public Health

Education = Education

Research = Scientific Departments

Transfers = Interest Payments + Pensions + Aid + Food Subsidy + Subscription Fees + Famine Relief + Compensation to Landlords + Public Works + Loans & Advances

Appendix E: Residuals for Regression (2) from Table 5.1.



Appendix F: Industry Results[10]

Table F.1 Agriculture (AGR) Industry
Dependent Variable: $Output_{AGR}/Worker_{AGR}$

Independent Variable	*(1)*	*(2)*
Year	.0095*	.0116*
	(0.002)	(0.000)
ln(G/Y)	-.2997**	-.4121*
	(0.012)	(0.000)
ln(Defense/Other)	-.0589	
	(0.389)	
ln(Infrastructure/Other)	.0016	
	(0.986)	
ln(Agriculture/Other)	-.0699***	-.0596***
	(0.073)	(0.096)
ln(Health/Other)	-.3202***	-.221***
	(0.096)	(0.068)
ln(Education/Other)	.1896	
	(0.256)	
ln(Research/Other)	.2070**	.2157**
	(0.047)	(0.043)
$\ln(Capital_{AGR}/Worker_{AGR})$	.7347*	.7297*
	(0.000)	(0.000)
Intercept	-16.2992**	-20.5684*
	(0.011)	(0.000)
R^2	.9566	.9546

Table F.2 Mining (MIN) Industry
Dependent Variable: $Output_{MIN}/Worker_{MIN}$

Independent Variable	*(1)*	*(2)*	*(3)*
Year	.031*	.0334*	.0329*
	(0.000)	(0.000)	(0.000)
ln(G/Y)	-.2872	-.3354***	-.3999**
	(0.147)	(0.09)	(0.021)
ln(Defense/Other)	.3397*	.3688*	.3595*
	(0.002)	(0.001)	(0.001)
ln(Infrastructure/Other)	-.1717	-.304*	-.2777*
	(0.296)	(0.005)	(0.005)
ln(Agriculture/Other)	-.2168*	-.2272*	-.2117*
	(0.000)	(0.000)	(0.000)
ln(Health/Other)	-.3368		
	(0.231)		
ln(Education/Other)	.4565***	.1183	
	(0.072)	(.462)	
ln(Research/Other)	.126		
	(0.341)		
$\ln(Capital_{MIN}/Worker_{MIN})$	.1939**	.1453**	.1678*
	(0.018)	(0.018)	(0.01)
Intercept	-55.2075*	-58.9605*	-58.4967
	(0.000)	(0.000)	(0.000)
R^2	.9858	.9846	.9846

[10] Numbers in parentheses are p-values.
* Indicates that the coefficient is statistically significant at the 1% level.
** Indicates that the coefficient is statistically significant at the 5% level.
*** Indicates that the coefficient is statistically significant at the 10% level.

Table F.3 Electricity (ELC) Industry
Dependent Variable: $Output_{ELC}/Worker_{ELC}$

Independent Variable	*(1)*	*(2)*
Year	.0241*	.0256*
	(0.000)	(0.000)
ln(G/Y)	-.0815	-.1657**
	(0.374)	(0.018)
ln(Defense/Other)	-.0111	
	(0.904)	
ln(Infrastructure/Other)	.0157	
	(0.821)	
ln(Agriculture/Other)	-.0645***	-.0748***
	(0.071)	(0.051)
ln(Health/Other)	-.5226*	-.5824*
	(0.000)	(0.000)
ln(Education/Other)	.4356*	.4373*
	(0.002)	(0.000)
ln(Research/Other)	.0217	
	(0.789)	
$\ln(Capital_{ELC}/Worker_{ELC})$	.551*	.5658*
	(0.000)	(0.000)
Intercept	-45.6524*	-49.247*
	(0.000)	(0.000)
R^2	.9955	.9951

Table F.4 Manufacturing (MFG) Industry
Dependent Variable: $Output_{MFG}/Worker_{MFG}$

Independent Variable	*(1)*	*(2)*
Year	.0534*	.0538*
	(0.000)	(0.000)
ln(G/Y)	-.3433*	-.4903*
	(0.007)	(0.000)
ln(Defense/Other)	.1432***	.1776*
	(0.058)	(0.001)
ln(Infrastructure/Other)	.0533	
	(0.420)	
ln(Agriculture/Other)	-.0747***	-.0771**
	(0.054)	(0.023)
ln(Health/Other)	-.4123*	-.3962*
	(0.008)	(0.000)
ln(Education/Other)	.2049	
	(0.268)	
ln(Research/Other)	-.104	
	(0.315)	
$\ln(Capital_{MFG}/Worker_{MFG})$	-.1022	-.0643
	(0.312)	(0.502)
Intercept	-96.925*	-98.39*
	(0.000)	(0.000)
R^2	.9922	.9932

Table F.5 Construction (CON) Industry
Dependent Variable: $Output_{CON}/Worker_{CON}$

Independent Variable	*(1)*	*(2)*
Year	-.0035	-.0047
	(0.669)	(0.268)
ln(G/Y)	.031	.0749
	(0.868)	(0.653)
ln(Defense/Other)	-.0223	
	(0.878)	
ln(Infrastructure/Other)	.1133	
	(0.243)	
ln(Agriculture/Other)	-.0254	
	(0.729)	
ln(Health/Other)	-.5309**	-.3749***
	(0.035)	(0.078)
ln(Education/Other)	.8621*	.7292*
	(0.005)	(0.005)
ln(Research/Other)	-.2669***	-.2029
	(0.067)	(0.157)
$\ln(Capital_{CON}/Worker_{CON})$	.6801*	.6504*
	(0.000)	(0.000)
Intercept	9.7884	13.1267
	(0.519)	(0.101)
R^2	.9765	.975

Table F.6 Services (SRV) Industry
Dependent Variable: $Output_{SRV}/Worker_{SRV}$

Independent Variable	*(1)*	*(2)*
Year	.0623*	.0647*
	(0.000)	(0.000)
ln(G/Y)	-.0564	. -.1424***
	(0.675)	(0.084)
ln(Defense/Other)	.0555	
	(0.512)	
ln(Infrastructure/Other)	.1547**	.1304***
	(0.031)	(0.055)
ln(Agriculture/Other)	-.0907**	-.0934*
	(0.026)	(0.001)
ln(Health/Other)	-.5521*	-.4331*
	(0.000)	(0.000)
ln(Education/Other)	.2807	
	(0.158)	
ln(Research/Other)	-.0609	
	(0.611)	
$\ln(Capital_{SRV}/Worker_{SRV})$	-.0741	-.1046
	(0.717)	(0.654)
Intercept	-114.6397*	-119.4465*
	(0.000)	(0.000)
R^2	.9959	.9959

Table F.7 Trade (TRD) Industry
Dependent Variable: $Output_{TRD}/Worker_{TRD}$

Independent Variable	*(1)*	*(2)*
Year	.0504*	.048*
	0	0
ln(G/Y)	-0.462	. -.6336***
	-0.31	-0.085
ln(Defense/Other)	-0.3247	
	-0.379	
ln(Infrastructure/Other)	.5148**	.5707**
	-0.042	-0.043
ln(Agriculture/Other)	0.1783	
	-0.337	
ln(Health/Other)	-1.0136*	-1.5705*
	-0.008	0
ln(Education/Other)	-0.2364	
	-0.624	
ln(Research/Other)	-0.0738	
	-0.749	
$\ln(Capital_{TRD}/Worker_{TRD})$	.5369*	.6049*
	-0.001	0
Intercept	-96.3626*	-94.2693*
	0	0
R^2	0.9812	0.9959

Table F.8 Communications (COM) Industry
Dependent Variable: $Output_{COM}/Worker_{COM}$

Independent Variable	*(1)*	*(2)*

	(0.598)	
ln(Infrastructure/Other)	.3562*	.3462*
	(0.000)	(0.000)
ln(Agriculture/Other)	.0018	
	(0.956)	
ln(Health/Other)	-.3337**	-.3665*
	(0.04)	(0.000)
ln(Education/Other)	.0301	
	(0.876)	
ln(Research/Other)	-.105	
	(0.209)	
ln($Capital_{COM}$/$Worker_{COM}$)	.4968*	.4497*
	(0.000)	(0.000)
Intercept	-106.2408*	-109.6491*
	(0.000)	(0.000)
R^2	.9983	.998

Appendix G: Growth Effects

Table G.1

Independent Variable	*(1)*
Year	.0078
	(0.548)
ln(G/Y)	9.6587
	(0.218)
Year*ln(G/Y)	-.0049
	(0.213)
ln(Infrastructure/Other)	11.1502*
	(0.009)
Year*ln(Infrastructure/Other)	-.0058*
	(0.009)
ln(Agriculture/Other)	-11.5294**
	(0.057)
Year*ln(Agriculture/Other)	.0058**
	(0.058)
ln(Health/Other)	-7.7854
	(0.662)
Year*ln(Health/Other)	.00372
	(0.679)
ln(Education/Other)	20.3991
	(0.197)
Year*ln(Education/Other)	-.0102
	(0.203)
ln(Capital/Worker)	.7104*
	(0.000)
Intercept	-14.0289
	(0.577)
R^2	.9958

F-test of joint significance:
(1) Year = 0
(2) ln(G/Y) = 0
(3) Year*ln(G/Y) = 0
(4) ln(Health/Other) = 0
(5) Year*ln(Health/Other) = 0
(6) ln(Education/Other) = 0
(7) Year*ln(Education/Other) = 0

F(7, 29) = 9.93
Prob > F = 0.0000

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