PUBLIC CAPITAL AND PRODUCTIVITY GROWTH:

A COST FUNCTION APPROACH

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CHAPTER I

INTRODUCTION

Statement of the Problem

The relation between the nation's shortfall of public capital investment and declining productivity growth has been a hot issue for researchers and politicians recently. Because productivity growth in the U.S. compared to other countries has lagged and because no single theory has provided an explanation of this lag, issues such as the effect of public capital investment on productivity and development have been the subject of many empirical investigations. Although this relationship is central to a number of research efforts, the effect of public capital investment on the nation's productivity and economic growth has not been clearly established. According to Ebert (1986), Neill (1986), Deno (1988), Aschauer (1988, 1989a,b,c, 1990a,b,c), Munnell (1990a,b), Conrad and Seitz (1994) and other studies, public investment has had a positive, and, in some cases, a great effect on the private sector economy. Other studies, however, such as Tatom (1990a,b), Hulten (1990), Eisner (1991), and Ford and Poret (1991) indicate that public capital investment has had nearly no impact on private sector output.

Objective of the Study

Although there is considerable controversy about the quantitative results, the importance of public capital investment in increasing productivity and economic growth has been generally accepted. One aspect of the problem that has not received enough attention, however, is the effect of public capital investment on individual industries. That is, little is known about which industries are most affected by the growth of public capital investment.

The need for a study of this problem is clear. Since publicly-provided inputs in the form of physical capital enter into the production process as an unpaid factor, public capital directly affects an individual firm's decision framework. It becomes important, then, for policy-makers at the federal, state, and local levels to know the quantitative effects of public capital investment.

The primary purpose of this research is to develop, estimate, and evaluate a model of the impact of public capital investment on the national economy, on the major sectors of the economy, and on the 20 manufacturing sectors. This research focuses on estimating total factor productivity, using a cost function approach. The relationships among inputs, especially between private and public capital, will also be examined for the whole U.S. economy.

Organization of the Study

This study begins with a review of the productivity issue. In Chapter II, a brief description of productivity and related topics, such as the definition and measurement of productivity, and why it is important for the economy, will be outlined. The U.S. productivity slowdown will be described. The literature on productivity and its slowdown will be reviewed. In Chapter III, the public capital hypothesis will be developed. The trend of U.S. public capital investment and its effect on private sectors of the economy will be analyzed. Arguments for and against the public capital hypothesis will be reviewed. Chapter IV presents the cost-function model used in this study to estimate the effects of public capital investment and the relationship between public and private capital inputs. Chapter V reports the empirical results of the study and their interpretation, along with data sources and methods used for data construction. The results tend to support the view of Munnell and Aschauer that public capital investment can play a significant role in reducing the costs of private firms, and thus increase the productivity of the private sector. Chapter VI provides a summary of the study and suggestion for future research.

CHAPTER II

REVIEW OF PRODUCTIVITY THEORIES

Introduction

U.S. productivity growth has slowed significantly since the early 1970s. More importantly, the growth rate in U.S. productivity has been lagging compared to our major competitors such as Germany and Japan. Many scholars have tried to explain the causes of the slowdown. In this chapter, definition and measurement of productivity will be stated first. Then, the importance of, and the U.S. trend in, productivity will follow. The existing theories explaining the U.S. slowdown in productivity growth will be briefly reviewed.

Definition and Measurement of Productivity

Productivity is a concept that shows the relationship between output -- the quantity of goods and services produced, and inputs -- the quantity of labor, capital, land, energy and other resources that produce output. When given quantities of inputs produce more output, productivity has increased.

The most common measure of productivity is labor productivity, which relates output to the input of labor time, that is, output per hour worked. This measure is widely used because it can be easily determined, and also because it is a key part of important information such as labor costs, quality of the labor force, and real labor income.

Another way of measuring productivity is total factor productivity (TFP).[1] TFP measures the contributions of all inputs -- capital, labor and intermediate materials -- to output. TFP is more difficult to estimate, but it provides more complete information about the causes of economic changes.

Moomaw (1987) describes labor productivity, TFP, and the relationship between the two very clearly by using simple mathematics. Using a Cobb-Douglas production function with two inputs, capital stock, K, and number of workers employed, L, the production function is

$$Y = A'K^{\alpha}L^{1-\alpha}, \qquad (0<\alpha<1), \tag{2.1}$$

where Y represents output and $A'(=Ae^{rt})$represents the effect of technology, with A representing a positive constant, *e* the natural *e* from mathematics, *r* the growth rate of technology, and *t* time.

Divide (2.1) by L to get

$$\frac{Y}{L} = \frac{A'K^{\alpha}L^{1-\alpha}}{L} = A'K^{\alpha}L^{-\alpha} = A'\left(\frac{K}{L}\right)^{\alpha}. \tag{2.2}$$

This equation states that the output per unit of labor, labor productivity, is determined by the level of technology A' and by the level of capital intensity (K/L). The level of technology is often called TFP. To see why, divide (2.1) by $K^{\alpha}L^{1-\alpha}$ to obtain

$$\frac{Y}{K^{\alpha}L^{1-\alpha}} = A' . \tag{2.3}$$

Thus, A' is total output divided by total factor inputs, and $Y/K^{\alpha}L^{1-\alpha}$ is denoted as TFP, just as Y/L is denoted as labor productivity. TFP is a measure of the overall efficiency of the economy's operation. It depends not only on technology but also on labor quality, management skill and much more. If TFP increases, clearly labor productivity will increase (see 2.2).

The other determinant of labor productivity is capital intensity, K/L. K/L is the amount of K available per worker. A worker using more K can produce more Y (see 2.2). By taking the logarithm of both sides in (2.2), we get

$$\log Y - \log L = \log A' + \alpha(\log K - \log L). \tag{2.4}$$

(2.4) shows that any percentage change in labor productivity (logY-logL) can be broken down into a percentage change in TFP (logA') and a weighted percentage change in capital intensity, $\alpha(\log K - \log L)$. In other words, in this two factor (K, L) framework, the percentage change in TFP can be computed as the difference between the percentage change in labor productivity and the weighted percentage change in capital intensity.

The Importance of Productivity Growth

Productivity growth plays a significant role in the nation's economy because it is a primary determinant of the future standard of living. If the efficiency of using given resources rises at 4 percent per year, real income and living standards will double every 18 years.[2] Garner (1988) confirmed that the slowdown of U.S. productivity growth is a big factor in the poor performance of the U.S. living standard since 1970.

According to a Bureau of Labor Statistics' study (1988), productivity growth has a great impact on key economic parameters:

1. When productivity increases slowly, prices generally rise more rapidly.
2. Increases in productivity are not necessarily associated with decreases in employment.
3. Real hourly compensation has generally increased in line with productivity growth.
4. Productivity growth has resulted generally in higher incomes and consumption rather than in additional leisure.

Besides these impacts, productivity growth has other important implications. A country with better productivity growth can provide better education, better medical treatment, and a cleaner environment. In the context of the global economy, lagging productivity growth means the loss of relative competitiveness of exports. This implies a restructuring of industrial organization, a reallocation of the labor force, and an abandonment of capital which is very costly to the national economy. The most important thing could be the impact on national defense. As Thurow (1992) has pointed out, economic strength is the most important element of national defense in this new world order era after the Cold War.

The Trend of U.S. Productivity Growth

Considering the importance of productivity growth, the current U.S. productivity slowdown has been a great concern for many scholars and politicians. Table I shows the trend in U.S. labor productivity for the period, 1960-1987. Labor productivity growth declined significantly from 2.7 in 1960-73 to 0.6 percent in 1973-79, and increased to 1.3 percent in 1979-87. If we exclude the significant productivity increases in the farm sector (4.3, 3.1, and 7.9 percent, respectively, in the three periods), the growth rate was even smaller.

As shown in Table II, TFP measured by output per unit of labor and capital input combined rose 1.1 percent per year between 1960 and 1986. During this period, however, the growth rate fell significantly from 1.8 in 1960-73 to 0.1 percent in 1973-79, and then slightly rose to 0.5 percent in 1979-86. Comparing the growth rates of TFP and labor productivity, the growth rate of TFP is much lower than that of labor productivity in all three periods. The trend of TFP is consistent, however, with that of labor productivity. Compared to the former West Germany, Japan, France and Canada, U.S. labor productivity growth was very slow in both 1973-79 and in

TABLE I

LABOR PRODUCTIVITY SINCE 1960 (IN PERCENT)

Period	Average Annual Changes	
	Business Economy	Nonfarm Business Economy
1960-87	1.8	1.6
1960-73	2.7	2.4
1973-79	0.6	0.5
1979-87	1.3	1.1

Source: Bureau of Labor Statistics (1988)

TABLE II

TFP IN THE PRIVATE ECONOMY (IN PERCENT)

Period	Average Annual Change
1960-86	1.1
1960-73	1.8
1973-79	0.1
1979-86	0.5

Source: Bureau of Labor Statistics (1988)

1979-86 (see Table III).

Although there are ups and downs among industries in terms of productivity growth[3], the problem we are facing is that the decline has been chronic and pervasive. It has affected almost all parts of the economy. Considering the trend of productivity growth we are having and the importance of it, this cannot be disregarded.

Factors Affecting the Productivity Slowdown

The question now is: Why has productivity growth been declining? To answer these questions, many analyses have been done by many scholars. Unfortunately, they have not produced an answer on which most can agree. The existing answers can be summarized as follows:

1. The decline of private capital investment per worker
2. More environmental regulations
3. The shift of resources from low-productivity sectors to higher-productivity sectors
4. The increase of energy prices
5. The decline of labor quality
6. Depletion of mineral resources and investment opportunity
7. Low non-military expenditures for research and development (R&D)
8. The decline of public capital investment.

Table III

LABOR PRODUCTIVITY OF SELECTED COUNTRIES (IN PERCENT)

Country	Average Annual	
	1973-79	1979-86
Canada	2.0	1.3
France	3.5	2.4
W. Germany	3.4	2.0
Japan	3.2	2.8
United States	0.3	0.6

Source: OECD Economic Studies, Spring 1988, p.20.

According to the BLS (1983), the decline of private capital investment explains about 40 percent of the slowdown in the private sector's productivity between 1973 and 1983, by comparing 1965-73 and 1973-79 BLS data. Norsworthy and Malmquist (1985) found that the fast increase in Japanese labor productivity was entirely attributable to the rapid accumulation of capital, facilitated by a high savings rate. They attribute the lack of U.S. private capital investment to the low saving rate (1/3 of Japan) in the United States.

Government's regulations on environment have been thought to contribute to the slowdown of productivity growth. To satisfy these regulations, firms have to divert productive private capital to non-productive pollution abatement facilities and equipments. Conrad and Morrison (1989) found that pollution abatement expenses decreased U.S. productivity growth by 0.223 percentage points in 1973-80. Barbera and McConnell (1986) found that environmental regulations reduced the productivity rate from 0.1 to 0.35 percentage points annually. Gollop and Roberts (1983) alleged that the 1970 Clean Air Act reduced the productivity growth of fossil-fueled electric utilities by 0.59 percentage points per year during 1973-79.

However, Crandall (1980), Denison (1985), Norsworthy, Harper and Kunze (1979) agree that regulatory requirements had small impacts on the slowdown. Most recently, Duffy-Deno (1992) found that a 10 percent increase in per unit total pollution abatement costs reduced total regional employment in Sun Belt SMSAs by only 0.17 percent during 1982. He concludes that there is weak support for the argument that pollution regulations adversely affect productivity growth.

Denison (1985) argues that the major contributor to the productivity slowdown was the end of the reallocation of labor from low productivity sectors to high productivity sectors. In his study, this explains 15 percent of the slowdown. The idea behind this theory is that, during the period of fast growth in productivity, there was a resource shift from low productivity sectors like agriculture to higher productivity sectors like manufacturing. Higher productivity sectors were the beneficiaries of the oversupply of the shifted resources. This source of productivity increase is no longer available because the agriculture sector is now one of the highest productivity sectors. This is a very controversial finding.

Many economists think that two oil shocks played a key role in the worldwide productivity slowdown. Jorgenson and Fraumeni (1981) and Jorgenson (1988) said that the sudden increase in energy prices due to the two oil shocks were important determinants of the productivity slowdown. Griliches (1988) agreed that the increase in energy prices is the main cause of the productivity slowdown after 1973. Tatom (1982) showed that the slowdown from 1973 to 1981 resulted from the rise in energy prices and the associated reduction in capital intensity.

Baily and Gordon (1988) and Olson (1988), however, disagreed with this view by claiming that productivity growth started to fall before the first oil shock of 1973. Berndt (1980) pointed out that energy costs are so small a portion of total costs that their impact is insignificant. Denison (1985) asserted that energy price increases were probably responsible for at most 0.1 percentage points of the slowdown.

Jorgenson, Gollop and Fraumeni (1987) argued that the decline of labor quality due to the influx of inexperienced young workers and women, and deteriorating education, accounted for 0.63 percentage points per year in the growth of productivity in 1973-79. Baily (1981), Bishop (1987) and Murname (1988) disagreed that a decline in educational quality was responsible for the productivity slowdown. Denison (1989) also shows that changes in the quality of the labor force are not significant explanations of the slowdown in productivity.

Nordhaus (1982) argued that the depletion of mineral resources and declining investment opportunities explained 65 percent (1.0 percentage point per year) of the U.S. productivity slowdown in 1973-79. What he observed is that TFP in mining in the U.S. grew at 2.6 percentage points annually during 1948-73, then declined at 2.8 percentage points annually from 1973-79. Since 1973, he argued, the finding of oil and gas has significantly decreased. In case of investment opportunity, he pointed out the slowdown in inventions and patent applications in the 1970s. Nordhaus' conclusions are quite debatable, because we appear to have had significant technological progress, especially in the telecommunications industry. Also, the advancement of technology in finding and extracting gas and oil has enabled us to cope with the depletion of these resources.

Kendrick (1979) found that the fall-off in R&D expenditures and its returns explain the substantial decline of productivity growth. Dean and Kunze (1988), Griliches (1988) and Scherer (1982), however, agreed that slowing R&D expenditures may have had some impact, but that it was not a major contributor to the slowdown. U.S. R&D expenditures per GDP, including military expenditures, is the highest among its competitors. When the military portion is excluded, the United States is behind Japan and Germany.

Many studies have attempted to solve the cause of productivity slowdown in the U.S. It is rather difficult to get a consensus on the importance of the various factors. The empirical results of these studies show that there is no major contributive factor in explaining the recent productivity slowdown.

CHAPTER III

PUBLIC CAPITAL HYPOTHESIS

Introduction

Recent and relatively unexplored subject in productivity analysis is the contribution of public capital investment. The idea is that since the nation's spending on public infrastructure has been declining since late the1960s, the lack of public capital stock has negatively affected the private sector's output, productivity, and capital formation. The idea is very natural and appealing. The first thing we can think of is that business firms and individuals lose time and money due to delays caused by congested highways, crowded airports, derailed trains, collapsed bridges and malfunctioning sewage systems. The most recent event that has increased the public awareness of the high cost of ignoring the deteriorating public infrastructure is the flooding in Chicago in April, 1992. This accident completely shut down the downtown business district for days, and resulted in the loss of billions of dollars.

Public Capital Hypothesis

According to Aschauer (1988, 1989a,b,c, 1990a,b,c), public capital, especially public infrastructure capital, has positive direct and indirect effects on the productivity of the private sector. The direct effect is that public capital investment provides intermediate services to the private sector which are virtually free for all businesses. In a production function of a firm, the more it uses public infrastructure facilities, the larger the marginal product of public capital.

The indirect effect arises from the complementarity between private and public capital in private sector production. An increase of public capital enhances the marginal product of private capital. In other words, the partial derivative of the marginal product of private capital with respect to public capital investment is positive.[4] This enhancement can spur the rate of expansion of the private sector's investment in plant and equipment. If there is a shortfall in public capital investment, private investment would not take place.

Aschauer concluded that infrastructure has a very strong positive effect on the private sector's total factor productivity. His studies show that a 1 percent increase in public capital investment will increase productivity up to 0.4 percent. This assertion, the so-called "Aschauer's hypothesis," or "public capital hypothesis" is confirmed by Garcia-Milà and McGuire (1992), and Munnell (1990a,b).

The Trend of Public Capital Investment

Public capital is provided by the government when the market system cannot provide necessary capital for the economy; that is, the market economy exhibits "market failure." Examples of goods provided publicly to correct market failures are national defense, public education, highways and roads, and social insurance. All of these goods are characterized to some, but differing degrees by non-rivalness and non-exclusiveness. The government should provide these goods and services to promote efficiency in resource allocation. Considering the nature of public goods, especially the free-rider problem, it is hard, however, to determine the optimal provision of public goods.

How much is the optimal accumulation of public capital? The answer is theoretically clear. When the present value of current and future goods and services produced by public capital equals the cost of public capital assets, then the level of public capital is optimal.[5] But it is very difficult to estimate these values, and the use of this criterion is controversial in many ways.[6]

There are two ways to investigate this issue indirectly. The first is to review the annual public capital investment historically and compare it with other countries. The second is to borrow the experts' views on the current status of the U.S. physical infrastructure.

According to Aschauer, our public capital investment has been declining and public capital consumption has been increasing. We are investing less on capital related to public production, such as infrastructure, and spending more on public consumption, such as health care. For example, the share of government spending on infrastructure peaked at 4.5 percent during 1961-70 and dramatically declined to 0.8 percent during 1981-87 (Table IV). Compared to its competitors, the U.S. has the lowest percentage of GDP invested in public capital in 1967 and 1985, respectively (Table V). Table VI shows the average annual percentage change in federal infrastructure spending. An average annual increase of total infrastructure spending reduced from 3.85% in 1971-80 to -1.15% during 1981-90. From this table, we can see that spending on water and sewage facilities dropped dramatically since 1980, and spending on aviation facilities increased steadily since 1970. Spending on highway decreased during the 1970s, and bounced back in the 1980s. According to Congressional Budget Office (1991), infrastructure spending as a percentage of all federal outlays has dropped significantly from 5 percent in 1960 to 2.5 percent in 1990. From this evidence, we can conclude that public capital investment has declined since the1960s.

Another way of checking the shortfall of public capital investment is the experts' views on the current situation. Gakenhelmer (1989) pointed out that public infrastructure facilities have a historical rhythm. The majority of our public infrastructure stock is due for rehabilitation all at once. For example, roads last around 20 years, bridges last around 50 years, major water supply facilities last around 100 years. The problem is that many of these

TABLE IV

THE GROWTH RATE OF TOTAL GOVERNMENT

SPENDING ON INFRASTRUCTURE (IN PERCENT)

Year	Average Annual Change
1951-60	3.9
1961-70	4.5
1971-80	2.0
1981-87	0.8

Source: Szabo (1989)

TABLE V

PUBLIC CAPITAL INVESTMENT OF MAJOR COUNTRIES

(% PER GDP)

Country \ Year	1967	1985
United States	1.7	0.3
Japan	3.8	4.1
W. Germany	3.1	1.5
France	3.5	1.6
United Kingdom	3.9	0.7
Canada	3.1	1.0

Source: Aschauer (1989c)

TABLE VI

ANNUAL AVERAGE PERCENTAGE CHANGE IN FEDERAL INFRASTRUCTURE SPENDING

Period	Total	Highway	Water and Sewage	Aviation
1959-90	1.67%	0.58%	1.99%	4.85%
1959-70	2.26%	2.01%	2.13%	0.00%
1971-80	3.85%	-1.80%	9.92%	6.93%
1981-90	-1.15%	1.37%	-6.10%	8.11%

Source:Congressional Budget Office (1991) infrastructure elements were built long ago, and are due now for replacement.

We are neglecting public capital spending, the facilities we built are getting worn out. Koepp (1988) and Szabo (1989) identified some of the infrastructure problems the U.S. face.

- Of the 3.8 million miles of roads in the U.S., 92 percent was built before 1960.
- Sixty-two percent of the paved highways need some form of rehabilitation.
- The cost of repairing the highways in poor to very-poor conditions is more than 164 billion dollars.
- Sixty-five percent of the traffic at peak travel times on interstate highways in urban areas in 1988 moved at an average speed of less than 35 miles an hour, up from 54 percent of traffic in 1983.
- Forty-two percent of the bridges more than 20 feet long need to be replaced or rehabilitated at a total cost of more than 50 billion dollars.
- Without any new major airport construction since 1974, airline passenger travel increased from 240 million trips in 1977 to 447 million in 1987.
- Congestion in airways and highways boosted the total cost of moving people and goods, which accounted for 17.6 percent of GNP in 1987.

- A shortage of airport capacity created a loss of 1.8 billion dollars for the airline industry, and 3.2 billion dollars for passengers in 1986. In 1987, the waste of fuel due to waiting accounted for about 3.6 percent of total fuel.
- In a poll of 461 top executives, 36 percent said they lost job efficiency because of air-travel delay.
- One manager of a trucking company said if drivers can get ahead of traffic, they can increase their productivity by 50 percent.
- The Associated General Contractors of America puts the cost of infrastructure needs at 3.3 trillion dollars.

Considering these facts, we can safely infer that we have a shortfall of public capital investment and stock, and the provision of public capital has probably been neglected since the1960s.

The Role of Public Capital to Private Sector

It is quite surprising that the effects of decline in the public capital stock have been neglected. The stock of public capital amounted to almost 2.1 trillion dollars, excluding military capital stock, compared to 4.7 trillion dollars in the private sector in 1990.[7] Since Samuelson's famous study (1954), it seems that the emphasis on public goods has been focused on consumption rather on production or public inputs. Adam Smith, however, emphasized the importance of the provision of public goods, especially infrastructure, as the third rationale for a government activity, along with the administration of justice and national defense.[8] Pigou (1932) argued that, even though a lighthouse cannot produce a final consumption good, the lighthouse service can enter as an input into a shipping companies' production function. Pigou said this was the "most important of all" (p. 185) aspects of public goods.

What can this "most important of all" factor do for a firm? In short, the public input, financed through taxation and distributed by governments, can be a subsidy for a firm, because it is an 'unpaid input' according to Meade's (1952) classification. Public inputs enter into a production process free of direct charge, unlike labor and private capital. Public inputs, therefore, have direct effects on firms' variable costs and profits. Since the tax payment is not directly related to the use of public inputs, a firm that uses more public inputs receives a larger subsidy. If one firm has that advantage, other firms in the same industry can take advantage of it, too. If they are located in the same area, the advantage no longer prevails. Rather this advantage can be reduced, because it is fixed in quantity unless the expansion of public capital investments occurs. Therefore, if more firms enter a region, a firm's share of the fixed public inputs will be diminished. In other words, the importance of public capital investment will increase, or the marginal product of public capital will increase because of the scarcity of public inputs, for example, in the case of congested highways. If other regions or countries heavily invest in public infrastructure, firms or industries in those area that use more public input with better infrastructure facilities will have an absolute advantage over those who use less. Also, public capital supports the private sector's production, and may increase marginal productivity of private capital and labor. If it does, firms will expand the private capital stock.

Complementarity and Substitution

The expansion of private capital due to the expansion of public capital is called the complementarity between public and private capital. This is a desirable outcome of public capital investment.

The other aspect of public capital investment is the substitution between public capital and private capital. The argument is that a crowding-out of private capital may occur because public capital is financed through taxation. If so, private capital will be substituted by public capital. Since private capital may have a better marginal rate of return than that of public capital, the substitution may not be desirable.

If there is a public capital investment shortage, however, private capital will substitute for public capital. For example, the lack of public safety causes firms to hire private security, and the decreased quality of public education requires firms to spend a great deal of money to train employees in reading, algebra and writing.

Let's assume that the government decides to promote a firm

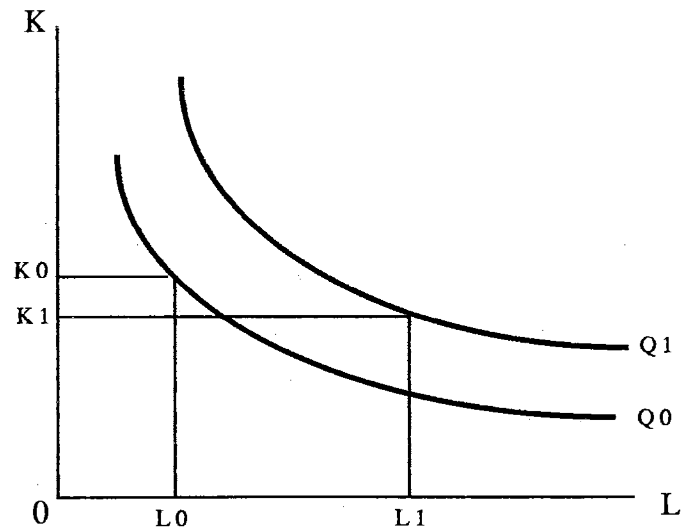

Figure 1. Public Capital and Labor are Complements

through public capital expansion to induce more private capital investment. As Figure 1 show, if a firm's isoquant shifts from Q_0 to Q_1 due to the public capital expansion, and we assume public capital and labor are complements, and public capital and private capital are substitutes in firm A's production, then the policy goal cannot be accomplished. Expansion of public capital causes more use of L, and less use of K. This policy is useful for reducing unemployment, not for raising private capital investment.

The decline of public capital investment will decrease the private capital investment if they are complements. If they are substitutes, firms that are using more public capital have to buy more private capital, since they have to fill the gap resulting from the decline of public capital. The increase of public capital, therefore, can be a good short-term policy for economic growth by alleviating a firm's capital pressure, even though they are substitutes. In the long-term, the increase in public capital could reduce economic growth if it is a substitute for private capital.

Some studies have examined these technical relationships between factors, including public capital and firm behavior. Ogura and Yohe (1979) pointed out that if public and private capital are complementary to each other, under-investment by the private sector can be counterbalanced by investment in public capital. Thus, public capital investment can be a useful policy to reduce any tendency of the private sector to under-invest. They emphasized that public capital investment should take place under careful scrutiny whether public and private capital are complementary or not. If the two types of capitals are complementary, public investment should be discounted at a lower rate. They even encouraged public capital investment regardless of its relation to private capital.

Abe (1990) proved under certain condition, in his two-good, two-factor, and one-public-input model, that the country that produces more public input exports the commodity of the industry that enjoys the spillover of the public input, and imports the other commodity.

Negishi (1973) mentioned that private capital will flow into the industries that use the most public unpaid input. If private capital and public capital are not perfect substitutes, the marginal rate of return to private capital will be larger in industries with higher levels of public capital. So more public capital is required in these industries to maximize the profits of private industries. McMillan (1978) showed that the stock of public capital investment can determine the slope of the production possibility frontier like other factors such as capital and labor, so it can be treated like a factor endowment that determines the patterns of trade.

Aschauer (1989a) finds that there is nearly a one-to-one crowding-out of private capital by public capital, but he also finds that there is nearly a one-to-one crowding-in of private investment over time with the increase of public capital investment, while holding the rate of return to private capital fixed. Eberts (1990) finds that there is reverse causation, which means the public capital investments can initiate private capital investments, and if private capital expands, public capital should follow.

Deno (1988) finds that public and private capital can be complementary. Dalenberg (1987) finds that public capital and labor are weak complements, while public capital, energy and private capital show a substitutive relationship. Eberts (1986) finds that public capital and labor are complements, and that public capital and private capital are substitutes. Costa, Ellison and Martin (1987) are unable to determine the relationship between public capital and private capital, but they find that public capital and labor are complements.

The relationships among inputs, especially between public capital and private capital are not clear yet. The nature of this relationship for individual industries is virtually unexamined.

The Effect of Public Capital

The size of the impact of public capital on the private sector is also important. Figure 2 illustrates this case. The production possibility frontier is shifted from T_0T_0 to T_1T_1 due to public capital expansion which is financed by lump-sum taxes. Public capital beneficiary good X will increase from X_1 to X_2, while public capital

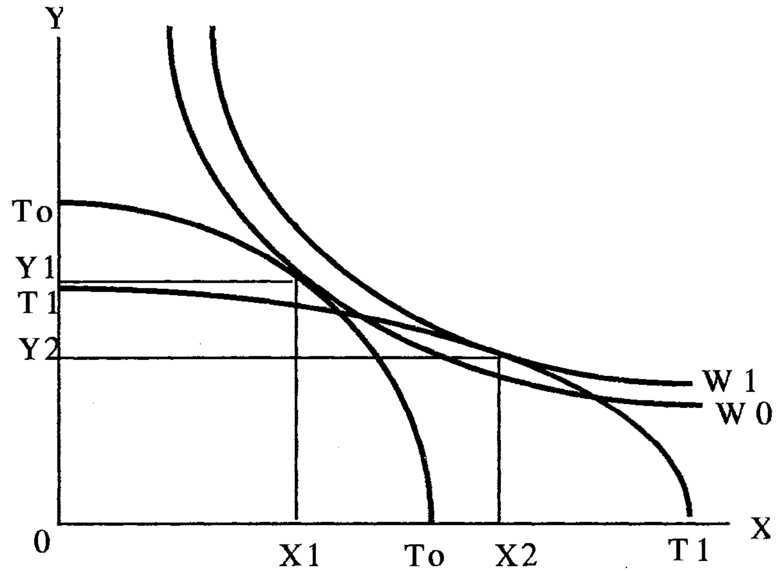

Figure 2. Public Capital Expansion Increases Welfare

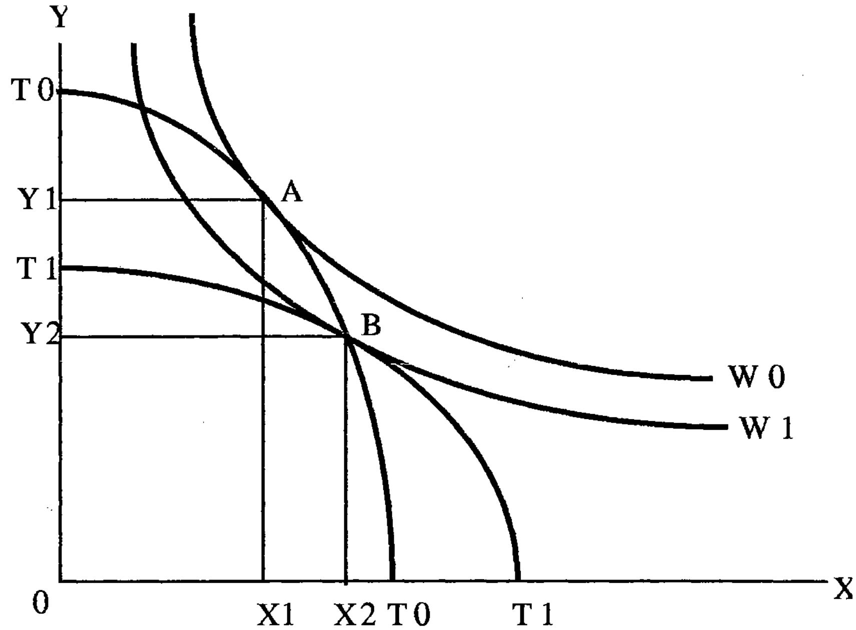

Figure 3. Public Capital Expansion Decreases Welfare

neutral good Y will decrease from Y_1 to Y_2. The increase of $\overline{X_1X_2}$ is greater than the decrease of $\overline{Y_1Y_2}$. Therefore, social welfare increases from W_0 to W_1. In other words, the effect of public capital investment must be big enough to offset the losses in public capital neutral goods due to taxes. If the elasticity of public capital investment with respect to good X is low or zero, the public capital investment is not worth while.

If a firm is neutral to public capital investment, then social welfare can decrease despite public capital expansion. Figure 3 shows that case. Point B is the intercept of T_0T_0 and T_1T_1, at which the same quantity of both X and Y goods can be produced with or without public capital expansion. The decrease of $\overline{Y_1Y_2}$ exceeds the increment of $\overline{X_1X_2}$ due to expansion. Therefore, in this situation, public capital expansion is simply a waste of tax dollars.

There are some empirical studies that investigate the relationship between public capital and other inputs. Aschauer (1988) finds that, based on time series analysis, the rate of return to private capital in the non-financial corporate sector is positively affected by changes in the stock of public capital investment. Aschauer (1989b, 1990c) also finds that a 'core infrastructure' has a significantly positive and statistically strong relationship to both labor and total factor productivity. Aschauer (1989c) uses cross-country data for the G-7 nations and finds that public non-military capital investment has a significantly positive relationship with GDP growth. He also finds that public capital consumption, including military expenditure, has a significant negative relationship to productivity growth. Aschauer (1990b) provides additional evidence that public nonmilitary capital investment has much greater stimulative effects on output than public capital consumption and military expenditure. Aschauer (1990a) employs measures of highway capacity and quality across 48 states during 1960 to 1985, and shows that highway capacity and quality has a stable and positive impact on income growth across regions.

Helms (1985) shows that government expenditures on highways, local schools, and higher education, positively and significantly affect personal income growth. Garcia-Milà and McGuire (1992) find the same results. They estimate a production function which includes highways and education along with private capital and labor, and find a significant relationship between public inputs and output growth. Keeler and Ying (1988) showed, using a cost function, that the rapid growth of highway infrastructure between 1950 and 1973 had a strong and positive effect on productivity growth in the trucking industry. The benefit of the highway infrastructure to the trucking industry, alone, is between one-third and one-half of the cost of the Federal-aid highway system over this period. Moomaw and Williams (1991) showed that state investments in education and in transportation infrastructure may affect TFP growth across the states. Deno (1988) finds similarly strong impacts of public capital investment in a translog profit function by employing data on manufacturing firms from 1970 to 1978. Morrison and Schwartz (1992), Munnell (1990a,b), and Eberts (1986) found a strong relationship between the public capital stock and productivity growth of the private sector.

Criticisms of the Public Capital Hypothesis

There are many criticisms of Aschauer's hypothesis. A recent Congressional Budget Office Study (1991) said that Aschauer's Conclusions are exaggerated, and that the relationship between public capital and private output is coincidental. For example, the members of young people from age 5 to 15 as a percentage of the total population has a similar correlation as the public capital stock with private output from 1951 to 1985.

The other important criticism of Aschauer in the CBO is that the statistical evidence is not robust; that is, large changes in statistical estimates will be obtained from small changes in the data or the statistical method used. For example, Aschauer's estimates of the marginal product of public capital can be changed enormously by small changes in data; either by substituting revised BLS data for original data, or by using different sample periods, e.g., 1949-85 versus 1950-85. By dropping one observation, the difference in the marginal product of public capital between the two sample periods is enormous - from 2.4 to 19.6. This study also shows that hospital construction and dams together have a marginal product more than twice that of all other public capital, including core infrastructure.

Aaron (1990), Eisner (1991), Tatom (1991), Hulten and Schwab (1991), and Jorgenson (1991) are also critical of Aschauer's hypothesis.

CHAPTER IV

PRESENTATION OF THE MODEL

Introduction

The need for public capital investment is generally accepted. There are two problems with the existing literature. The first problem is the quantitative results of Aschauer's test of public capital hypothesis. The reported effect of public capital investment is too large for many economists, and the statistical results are not robust. The other problem is that the effect of public capital investment depends on how specific industries will respond, that is, on the elasticity of industry costs to changes in public capital investment. If a country or a state has a majority of industries which are neutral to the increase of public capital investment, social welfare can decrease as shown in Figure 3. Unfortunately, we do not know from the results of the public capital studies to date if this is the case.

To address these issues, we use a cost-function to provide more accurate results in estimating economic parameters, unlike Munnell's and Aschauer's studies which employ production function. Using this approach, we estimate the responsiveness of individual industries to the change of public capital investment. We expect that there will be differences among industries with regard to the elasticity of industry costs to public capital investment. Some industries may be more affected by public capital investment than others.

We will also investigate the relationships among factors, especially between private capital and public capital in the national economy by using the cost function. Public capital and private capital can be substitutes or complements.

Models for Testing for Complementarity and Substitution among Inputs

To measure productivity or economic parameters, either a production function approach or a cost function approach can be used. Microeconomic theory tells us that there is no difference between the two. Thanks to the duality theorem, maximization of output is equivalent to minimization of cost.

However, the cost function approach has some advantages over the production function approach in estimating certain parameters. According to Binswanger (1974), there are three major advantages in using a cost function approach. First, the cost function can be used without any restriction on the returns to scale in underlying technology. Second, the cost function can provide direct estimates of Allen elasticities of substitution that describe the complementarity and substitutability among the factors of production. In the production function approach, these elasticities must be estimated through the inversion of the production function coefficient matrix.

This procedure exaggerates the estimation errors, and reduces the precision of statistical work. Third, there is little multicollinearity among factor prices, unlike the production function with its high multicollinearity among input variables.[9]

In microeconomic theory, a firm produces output by combining capital, labor, and intermediate inputs at given prices. When input prices, level of output, or technology change, a firm reacts by choosing a different mix of inputs to maximize output. In this study, we have to include one more input, public capital investment. The general form of the production function including public capital is $Y = Y(K, L, G, T)$, where Y is the level of output, K is private capital investment, G is public capital investment, L is labor and T is technology, which is assumed to be a simple function of time.

Adopting duality, and assuming that the firm minimizes the total cost of production, the cost function can be written

$$C = C(\mathbf{P}, Y, G, T), \tag{4.1}$$

where C, and **P**, are total cost and a vector of input prices, respectively. The translog approximation of this generalized cost function is

$$\begin{aligned} \log C = {} & \alpha_0 + \alpha_Y \log Y + \frac{1}{2}\alpha_{YY}(\log Y)^2 + \sum_i \alpha_i \log P_i \\ & + \frac{1}{2}\sum_i \sum_j \gamma_{ij} \log P_i \log P_j + \sum_i \gamma_{Yi} \log Y \log P_i + \sum_i \theta_i \log P_i \log T \\ & + \theta_Y \log Y \log T + \beta_t \log T + \frac{1}{2}\beta_{tt}(\log T)^2 + \sum_i \delta_i \log P_i \log G \end{aligned} \tag{4.2}$$

where i, j equal to L, K. A set of cost-share equations can be obtained from Shephard's lemma, which is the derived demand for an input, X_i, obtained by partially differentiating the cost function with respect to factor price, i.e., $\partial C(\cdot)/\partial P_i = X_i$.

$$S_i = \alpha_i + \frac{1}{2}\sum_i \gamma_{ij}\log P_j + \gamma_{Yi}\log Y + \theta_i \log T + \delta_i \log G \qquad (4.3)$$

where $S_i = P_i X_i / C = \partial \log C / \partial \log P_i$ is the share of the costs accounted for by the factor *i*. Several parametric restrictions on the translog cost function must be imposed; most importantly the cost function must be linearly homogeneous in factor prices at all values of factor prices, output, technology and public capital input.[10] This requires that:

$$\sum_i \alpha_i = 1, \ \sum_i \sum_j \gamma_{ij} = \sum_i \gamma_{ij} = \sum_j \gamma_{ij} = 0$$

$$\sum_i \gamma_{Yi} = \sum_i \theta_i = \sum_i \delta_i = 0, \text{ and}$$

$$\sum_i S_i = 1.$$

The Allen-Uzawa partial elasticity of substitution between two factors, *i* and *j*, the output-compensated price elasticities of factor demand, can be estimated from the translog function.[11]

The Allen-Uzawa partial elasticity of substitution is:

$$\sigma_{ij} = \frac{\gamma_{ij}}{S_i S_j} + 1, \qquad \text{for } i \text{ and } j. \qquad (4.4)$$

The Output-compensated price elasticities are:

$$\eta_{ij} = \frac{\gamma_{ij}}{S_i} + S_j, \qquad \text{for } i \text{ and } j. \qquad (4.5)$$

The relationship between private capital and public capital will be estimated by using (4.4) and (4.5). These elasticities will provide the relationship between factors; i.e., determine if they are complements or substitutes.

The Effect of Public Capital on TFP Growth

The objective of this section is to develop a model which can identify the effect of public capital input on TFP growth by separating other influences such as scale effects in individual industries. According to Gollop and Jorgenson (1980), the TFP growth rate can be defined as

$$W = \frac{d\log Y}{dT} - \frac{d\log F}{dT}, \tag{4.6}$$

where W is the rate of TFP growth, and F denotes total factor input. For measuring F, a Divisia Index is used,

$$\frac{d\log F}{dT} = \sum_i \frac{P_i X_i}{C} \cdot \frac{d\log X_i}{dT} = \sum_i S_i \frac{d\log X_i}{dT},$$

where $C \equiv \sum_i P_i X_i$.

The main differnece in next step compared to Gollop and Jorgenson is the inclusion of variable G. The next step is that we take the logarithmic differentiation of the cost function, (4.1) with respect to time. This yields the following equation (4.7):

$$\frac{d\log C}{dT} = \sum_i S_i\left(\frac{d\log P_i}{dT}\right) + \frac{\partial \log C}{\partial \log Y}\left(\frac{d\log Y}{dT}\right) + \frac{\partial \log C}{\partial \log G}\left(\frac{d\log G}{dT}\right) + \frac{\partial \log C}{\partial T}.$$

$\frac{\partial \log C}{\partial \log Y}$ measures the returns to scale effect on costs, $\frac{\partial \log C}{\partial \log G}$ measures the effect of the public capital stock on costs, and $\frac{\partial \log C}{\partial T}$ measures the shift in the cost function due to technology.

$\frac{\partial \log C}{\partial T}$ can be obtained by rearranging (4.7), as follows;

$$\frac{\partial \log C}{\partial T} = \frac{d\log C}{dT} - \sum_i S_i \frac{d\log P_i}{dT} - \frac{\partial \log C}{\partial \log Y}\left(\frac{d\log Y}{dT}\right) - \frac{\partial \log C}{\partial \log G}\left(\frac{d\log G}{dT}\right). \tag{4.8}$$

Logarithmically differentiating $C = \sum_i P_i X_i$ with respect to time yields:

$$\sum_i S_i \frac{d\log P_i}{dT} = \frac{d\log C}{dT} - \sum_i S_i \frac{d\log X_i}{dT}. \tag{4.9}$$

Substituting (4.9) in (4.8), produces:

$$\frac{\partial \log C}{\partial T} = - \frac{\partial \log C}{\partial \log Y}\left(\frac{d\log Y}{dT}\right) - \frac{\partial \log C}{\partial \log G}\left(\frac{d\log G}{dT}\right) + \sum_i S_i \frac{d\log X_i}{dT}. \tag{4.10}$$

By rearranging terms,

$$\sum_i S_i \frac{d\log X_i}{dT} = \frac{\partial \log C}{\partial \log Y}\left(\frac{d\log Y}{dT}\right) + \frac{\partial \log C}{\partial \log G}\left(\frac{d\log G}{dT}\right) + \frac{\partial \log C}{\partial T}. \tag{4.11}$$

Substituting (4.11) in (4.6) yields the rate of TFP growth, W,

$$W = (1 - \frac{\partial \log C}{\partial \log Y})\left(\frac{d\log Y}{dT}\right) - \frac{\partial \log C}{\partial \log G}\left(\frac{d\log G}{dT}\right) - \frac{\partial \log C}{\partial T}. \tag{4.12}$$

For simplicity, we let $\varepsilon_{cY} = \frac{\partial \log C}{\partial \log Y}$, $\varepsilon_{cG} = -\frac{\partial \log C}{\partial \log G}$, and $\varepsilon_{cT} = -\frac{\partial \log C}{\partial T}$. (4.12) shows the decomposition of TFP growth into three sources: the returns to scale effect, $(1 - \varepsilon_{cY})$, the effect of public capital investment, ε_{cG}, and the shift of the cost function due to technology, ε_{cT}. The rate of TFP growth is simply, $W = \varepsilon_{cT}$, when constant returns to scale prevails and the effect of public capital investment is zero.

These elasticities can be estimated in two ways. First, (4.12) can be transformed into a regression equation:

$$W = b_0 + b_1 \left(\frac{d\log Y}{dT}\right) + b_2 \left(\frac{d\log G}{dT}\right) + b_3 T, \qquad (4.13)$$

where ε_{cT} is replaced by $b_0 + b_3 T$, b_1 represents $(1- \varepsilon_{cY})$, and b_2 represents ε_{cG}. If b_1 is positive (negative), it implies increasing (decreasing) returns to scale. If b_2 is positive, it implies that public capital investment decreases the average variable cost of the firm.

The second method is to use the translog cost function (4.2) and get the elasticities from the parametric estimates of the model:

$$\varepsilon_{cY} = \alpha_Y + \alpha_{YY}\log Y + \sum_i \gamma_{Yi}\log P_i + \theta_Y \log T + \delta_Y \log G, \qquad (4.14)$$

$$\varepsilon_{cG} = \sum_i \delta_i \log P_i + \delta_Y \log Y + \delta_t \log T + \rho_G + \rho_{GG}\log G. \qquad (4.15)$$

These elasticities are estimated using the first method.

Finally, TFP growth can be decomposed to determine the contribution of public capital. ε_{cY} and ε_{cG} from (4.13) can be obtained.

CHAPTER V

ECONOMETRIC RESULTS AND INTERPRETATION

Hypothesis

Basically two tests will be performed in this study. The first one is to test the relationship between public capital and private capital, that is, whether σ_{ij} or η_{ij} are zero or not. If σ_{ij} or η_{ij} are not zero, a positive (negative) sign for σ_{ij} means the two factors are substitutes (complements). If the sign of η_{ij} is positive (negative), the two factors are substitutes (complements). The sign of η_{ii} is expected be negative.

The second test is to determine the impact of public capital on costs, that is, whether ε_{cG} is zero or not. If ε_{cG} is not zero, we expect the sign of ε_{cG} to be positive. If it is, this means that the increase of public capital investment decreases costs of the firm, because $\varepsilon_{cG} = -\frac{\partial \log C}{\partial \log G}$.

The Data

The major data used in this study consist of annual data on the quantities and prices of three inputs, labor, private capital, and public capital, and one output, gross domestic product for 1958 through 1991 (except services and transportation, where the available data begins in 1965). The data sources and their construction are as follows:

Private capital (K): the current-cost net stock of fixed private capital-both residential and nonresidential-by industry. Source: Musgrave (1992,93).

Public capital (G): the current-cost net stock of government-owned fixed capital, excluding military. Source: Musgrave (1992,93).

Labor (L): the number of nonsupervisory or production workers. Source: Department of Labor Bulletin (1984,92).

Price of Labor (PL): nonsupervisory or production workers' average weekly earnings in current dollars. Source: Department of Labor Bulletin (1984,92).

Quantity (Y): gross domestic product in current dollars. Source: Survey of Current Business (May, November, 1993).

Price of Public Capital (PG): According to Morrison and Schwartz (1992), PG is defined as, $PG=PI(r+\lambda)$, where r is the cost of funds, λ is a depreciation rate, and PI is a deflator for capital plant and equipment. Moody's long-term government bond yield is used for r. PI is the ratio of the current and constant (1987) dollar net stock of fixed nonresidential private capital. The depreciation rate (λ) is the current dollar value of the capital consumption allowance divided by the current dollar value of the stock of net fixed private capital. Source: National Income and Product Accounts, 1929-58, National Income and Product Accounts 1959-88. Survey of Current Business, (January, 1992), (August, September, 1993).

Price of Private Capital (PK): Following Morrison and Schwartz, PK is defined as, $PK=(1+\tau)PI(r+\lambda)$. The difference between PK and PG is the addition of τ, the tax rate. Moody's Aaa corporate bond rate is used for r. The average effective tax rates are calculated as, τ=(before tax profits-after tax profits)/before tax profits. Source: National Income and Product Accounts, 1948-82, National Income and Product Accounts,1959-88. Survey of Current Business, (January, 1992), (August, September, 1993). The data for PK and τ are presented in the Appendix. A comparison with Morrison and Schwartz's PK is presented in the Appendix.

The data for PK and PG show that PKs are higher than PGs in all occasions. The average effective corporate tax rate for the total economy is 40.1 percent in the study period. The finance, insurance and real estate industry has paid the highest tax rate of 67.2 percent, and the mining industry has paid the lowest tax rate of 30.2 percent. In manufacturing, the electric and electronic equipment industry has paid the highest tax rate of 58.2 percent, and the lumber and wood products industry has paid the lowest tax rate of 13.7 percent.

Empirical Results and Interpretation

The Relationship Between Public And Private Capital

For the national economy, public capital enters as an endogenous input unlike in (4.1), where $C=C(\mathbf{P}, Y, G, T)$. Now $\mathbf{P}$ is a vector of input prices of K, L, and G, unlike **P** in (4.1), which is a vector of input prices of only K and L. Then (4.3) becomes

$$S_i = \alpha_i + \frac{1}{2}\sum_i \gamma_{ij}\log P_j + \gamma_{Yi}\log Y + \theta_i \log T \qquad (5.1)$$

where i , j are equal to L, K, and G.

The eighteen parameters of these equations are estimated by Zellner's seemingly unrelated regression technique. This technique yields

$$S_K = \underset{(1.977)}{107.18} + \underset{(9.307)}{.344}\log P_K - \underset{(-7.329)}{.264}\log P_G - \underset{(-2.052)}{.079}\log P_L + \underset{(3.966)}{.182}\log Y -$$

$$\underset{(-1.968)}{14.178}\log T \qquad (5.2)$$

R-squared=.9806

$$S_G = \underset{(.311)}{17.610} - \underset{(-7.325)}{.264}\log P_K + \underset{(4.071)}{.168}\log P_G + \underset{(2.342)}{.096}\log P_L + \underset{(.666)}{.032}\log Y -$$

$$\underset{(-.315)}{2.375}\log T \qquad (5.3)$$

R-squared=.6668

$$S_L = \underset{(-1.206)}{-123.79} - \underset{(-2.052)}{.079}\log P_K + \underset{(2.342)}{.096}\log P_G - \underset{(-.2166)}{.016}\log P_L - \underset{(-2.462)}{.214}\log Y +$$

$$\underset{(1.214)}{16.553}\log T \qquad (5.4)$$

R-squared=.9478

The estimation of the system of equations performed well. The parameters of interests, -.264, the estimates of γ_{kg} and γ_{gk}, are statistically significant. The t-statistics (in parentheses) are very high. The Wald chi-square statistic for testing the null hypothesis,

TABLE VII

ESTIMATES OF σ_{gk} AND η_{gk}

Year	σ_{gk}	η_{gk}
1958	-1.588717	-.8416129
1959	-1.653663	-.8662814
1960	-1.663165	-.8666808
1961	-1.608192	-.8392668
1962	-1.603332	-.8209563
1963	-1.569624	-.8014284
1964	-1.554203	-.7894657
1965	-1.540124	-.7781389
1966	-1.467628	-.7524251
1967	-1.393081	-.7264064
1968	-1.312354	-.7045119
1969	-1.239106	-.6747496
1970	-1.105365	-.6147379
1971	-1.023106	-.5774366
1972	-.9899047	-.5657990
1973	-.9117887	-.5272503
1974	-.7188780	-.4256634
1975	-.6906138	-.4281293
1976	-.7148473	-.4519193
1977	-.6956745	-.4432534
1978	-.6294424	-.4008401
1979	-.5773377	-.3700653
1980	-.5634316	-.3732593
1981	-.5943087	-.4060153
1982	-.6194304	-.4315811
1983	-.6328731	-.4421798
1984	-.6441003	-.4511692
1985	-.6668521	-.4719064
1986	-.7102983	-.5116603
1987	-.6832931	-.4885308
1988	-.6612842	-.4710072
1989	-.6558612	-.4726442
1990	-.6378006	-.4591049
1991	-.6161648	-.4421891

$\gamma_{kg} = 0$, is 53.6545 with 1 degree of freedom. The critical value at the 5 percent significance level is 7.87944; thus the null hypothesis is rejected. The important thing in this equation is the sign of two parameters, which is negative in both cases.

By using (4.4) and (4.5), we can get σ_{gk} and η_{gk} the Allen-Uzawa partial elasticity of factor substitution and the output-compensated price elasticity of factor demand. Table VII shows σ_{gk} and η_{gk} for 1958-1991. The signs are both negative, which means that the two inputs, private capital and public capital, are complements. The trends of both estimates are very consistent. In the early period, 1958-73, the σ_{gk} estimates show that both inputs are strong complements. Complementarity is somewhat weaker after 1973. The reason for weaker complementarity is that the share of labor cost in total cost declines, accordingly, the absolute value of σ_{gk} also declines. Public capital and labor are substitutes, however. The sign of two parameters is positive.

These findings have important implications for regional or national policy-makers. An increase in public capital stock can cause the increase of private capital investment, and the decrease of labor employment. That is, a region or a nation becomes more capital-intensive. This means that a increase of public capital will expand the regional economy through the attraction of private capital, so the regional employment can increase through the expansion. However, this increase of labor employment can be tempered somewhat as production activity becomes more capital-intensive.

The Effect of Public Capital

In this section, G will be treated as given, because industries cannot control the amount or availability of public capital investment. This means that $C=C(\mathbf{P}, Y, G, T)$. Based on (4.13), returns to scale, $(1-\varepsilon_{cY})$ and the elasticity of cost with respect to public capital, (ε_{cG}), are estimated using Cochrane-Orcutt procedure. This procedure is used because in most time series analysis as in this study, serial correlation of residuals is a serious and common problem with estimates based solely on ordinary least squares technique.

Tables VIII and IX show the empirical results for $(1-\varepsilon_{cY})$ and ε_{cG}, along with the Durbin-Watson statistic and value of the R-squared estimator. All regressions performed well, except the wholesale trade industry. The tables show that the estimate of the scale effect is positive in every case for the whole period 1958-91. Most of the scale effects are statistically significant. This means that increasing returns to scale effects dominated the private, nonfarm economy. The value of $(1-\varepsilon_{cY})$ for the total economy over the entire period is 0.7518. This means that, on average, a 1% increase in output resulted in a 0.7518% increase in total cost.

For the various sub-periods, especially during 1958-75, the coefficients for $(1-\varepsilon_{cY})$ in the construction industry, the services

TABLE VIII

REGRESSION RESULTS: DEPENDENT VARIABLE=TFP GROWTH

Industry	Period	Intercept	Returns to Scale	Cost/public capital elasticities	Technological Change	D.W.	R-squared
Total economy	1958-91	-1.6604	.7518	.3031	.0008	2.085	.814
		(-0.576)	(10.256)	(6.017)	(.5664)		
	1958-75	6.7965	.6791	.3291	-.0035	2.074	.947
		(5.099)	(6.878)	(7.858)	(5.099)		
	1976-91	-5.4333	.7737	.2926	.0027	1.967	.808
		(-2.485)	(6.705)	(3.942)	(2.475)		
Retail trade	1958-91	2.5026	.7021	.3068	-.0013	1.825	.813
		(3.057)	(6.809)	(4.662)	(5.469)		
	1958-75	3.2091	.7469	.3069	-.0016	1.928	.923
		(1.874)	(5.164)	(3.267)	(-1.867)		
	1976-91	-6.5180	.9330	.2726	.0033	1.932	.808
		(-.855)	(5.384)	(2.593)	(.849)		
Finance, insurance, and real estate	1958-91	-.0137	.5711	.3490	-.2833	1.830	.696
		(-.745)	(4.087)	(4.718)	(3.370)		
	1958-75	.0362	.1194	.4892	-.0433	2.023	.851
		(1.628)	(.7992)	(4.770)	(-.747)		
	1976-91	.0312	.3887	.4193	-.4055	2.338	.807
		(1.455)	(2.726)	(3.805)	(-3.530)		

( ) denotes t-statistics.

TABLE VIII (CONTINUED)

REGRESSION RESULTS: DEPENDENT VARIABLE=TFP GROWTH

Industry	Period	Intercept	Returns to Scale	Cost/public capital elasticities	Technological Change	D.W.	R-squared
Manufac-turing	1958-91	.6519	.8117	.4007	-.0003	1.881	.885
		(.339)	(13.502)	(5.492)	(-.402)		
	1958-75	3.7296	.7039	.4013	-.0019	2.220	.941
		(1.672)	(6.670)	(4.810)	(-1.671)		
	1976-91	-6.5997	.8889	.3264	.0033	1.956	.927
		(-1.660)	(14.085)	(1.970)	(1.654)		
Mining	1958-91	-9.1595	.7574	.0101	.0046	1.980	.805
		(-.913)	(10.981)	(.039)	(.909)		
	1958-75	14.0373	.7162	.2437	-.0072	1.899	.916
		(4.231)	(7.205)	(.938)	(-4.238)		
	1976-91	-29.1894	.6698	.3313	.0147	2.074	.877
		(-2.542)	(6.949)	(.674)	(2.544)		
Whole-sale trade	1958-91	1.3465	.6030	.1961	-.0007	1.949	.603
		(.659)	(6.338)	(2.285)	(-.643)		
	1958-75	-.6024	.3381	.2226	.0003	2.109	.450
		(-.316)	(1.864)	(1.964)	(.319)		
	1976-91	-8.5514	.5744	.0476	.0042	2.125	.697
		(-1.216)	(4.218)	(.240)	(1.211)		

( ) denotes t-statistics.

TABLE VIII (CONTINUED)

REGRESSION RESULTS: DEPENDENT VARIABLE=TFP GROWTH

Industry	Period	Intercept	Returns to Scale	Cost/public capital elasticities	Technolgical Change	D.W.	R-squared
	1958-91	.4816	.6326	.4123	-.0002	1.915	.801
		(.527)	(8.668)	(4.909)	(-.503)		
Construc-tion	1958-75	-.8414	.1266	.3611	.0004	2.047	.717
		(-.492)	(1.173)	(5.390)	(.5284)		
	1976-91	5.1836	.7301	.8312	-.0026	2.395	.908
		(1.535)	(9.470)	(3.934)	(-1.528)		
Transport-ation and Public Utilities	1965-91	-8.2027	1.1284	.2529	.0041	2.046	.858
		(-2.199)	(9.184)	(3.631)	(2.186)		
	1965-75	9.741	1.0122	.2952	-.0050	1.971	.937
		(.347)	(4.548)	(4.742)	(-.352)		
	1976-91	-2.852	.9308	.7345	.0014	1.714	.904
		(-1.099)	(6.862)	(4.692)	(1.102)		
	1965-91	.2912	.5487	.2716	-.0002	1.744	.705
		(.313)	(4.497)	(4.468)	(-.325)		
Services	1965-75	-.4554	.2692	.2618	.0002	2.282	.992
		(-.188)	(1.107)	(7.353)	(.195)		
	1976-91	-3.6151	.9892	.1458	.0018	2.043	.789
		(-1.071)	(7.871)	(.823)	(1.055)		

( ) denotes t-statistics.

TABLE IX

REGRESSION RESULTS: DEPENDENT VARIABLE=TFP GROWTH, MANUFACTURING, 1958-1991

Industry	Intercept	Returns to Scale	Cost/public capital elasticities	Technolgical Change	D.W.	R-squared
Lumber and wood products	.1876 (.085)	.8653 (21.450)	.4947 (4.302)	-.0000 (-.083)	2.025	.948
Furniture and fixtures	2.4480 (3.253)	.6583 (8.394)	.3990 (3.971)	-.0012 (3.274)	2.079	.804
Stone, clay and glass products	-2.1684 (-.820)	.9696 (15.939)	.4998 (4.366)	.0011 (.820)	1.986	.932
Primary metal industries	3.8193 (1.454)	.9849 (6.715)	1.4414 (3.850)	-.0018 (-1.425)	2.006	.611
Fabricated metal products	.9762 (1.638)	.6911 (8.595)	.3601 (3.367)	-.0005 (-.602)	1.764	.755
Machinery, except electrical	1.7547 (.753)	.7701 (12.591)	.4614 (4.339)	-.0009 (-.760)	1.890	.849
Electric and electronic equipment	4.4501 (2.280)	.6600 (5.670)	.5278 (3.172)	-.0022 (-2.286)	1.850	.724
Motor vehicles and equipment (other transportation equipment)	2.0966 (1.164)	.8724 (11.013)	.5653 (3.084)	-.0010 (-1.174)	1.983	.909
Instruments and related products	2.8418 (1.268)	.9237 (25.923)	.5239 (4.013)	-.0015 (-1.287)	1.814	.948
Miscellaneous manufacturing industries	1.3685 (.7738)	.9846 (15.207)	.5993 (4.400)	-.0007 (-.776)	1.850	.865

( ) denotes t-statistics.

TABLE IX (CONTINUED)

REGRESSION RESULTS: DEPENDENT VARIABLE=TFP GROWTH, MANUFACTURING, 1958-1991

Industry	Intercept	Returns to Scale	Cost/public capital elasticities	Technolgical Change	D.W.	R-squared
Food and kindred products	1.5453 (.653)	.8630 (12.717)	.3236 (4.337)	-.0008 (-.668)	1.994	.872
Tobacco manufactures	2.0570 (.440)	.9309 (9.206)	.3327 (1.220)	-.0010 (-1.220)	2.016	.685
Textile mill products	-.4433 (-.226)	.8847 (17.400)	.2759 (3.186)	.0002 (.218)	2.206	.898
Apparel and other textile products	.5550 (.693)	.5472 (5.537)	.2124 (2.677)	-.0003 (-.679)	1.905	.619
Paper and allied products	1.7590 (.719)	.9703 (17.071)	.3964 (4.238)	-.0009 (-.735)	1.813	.888
Printing and publishing	3.8892 (4.721)	.7804 (11.414)	.3614 (5.278)	-.0020 (-4.751)	1.847	.880
Chemicals and allied products	.3282 (.130)	.9608 (15.678)	.4248 (4.373)	-.0002 (-.149)	1.987	.851
Petroleum and coal products	-4.8554 (-.580)	.9924 (45.659)	.2454 (1.678)	.0024 (.574)	1.961	.969
Rubber and miscellaneous plastic products	.7189 (1.006)	.7585 (11.835)	.6486 (8.030)	-.0004 (-1.022)	1.865	.899
Leather and leather products	1.2210 (.626)	.7232 (7.385)	.1867 (1.263)	-.0006 (-.838)	1.977	.725

( ) denotes t-statistics.

industry, the wholesale trade industry, and finance, insurance, and real estate industry are statistically insignificant. The transportation and public utilities industry is mostly dominated by returns to scale.

Most of the estimates of ε_{cG} have the expected sign, which is positive. The increase in public capital decreases the cost of the firm, thus improving the rate of productivity growth. All of the estimates of ε_{cG} are statistically significant. For the total economy in the entire period, the ε_{cG} of 0.3031 means that a 1% increase in public capital spending results in a 0.3031% reduction in total cost. The value of ε_{cG} in the two sub-periods for the total economy are very consistent with ε_{cG} over the period. Public capital investment cannot explain the growth rate of TFP in the mining industry and the wholesale trade industry in most periods. It appears that manufacturing, transportation and public utilities, and construction have been affected the most, and the most consistent, by public capital investment. The technological change variable is not statistically significant in most cases.

In the 20 manufacturing industries, most industries are dominated by increasing returns, especially the petroleum and coal products and primary metal industries. All estimates of $(1-\varepsilon_{cY})$ in all 20 industries are statistically significant. The values for ε_{cG} in most industries are statistically significant except for tobacco manufactures, petroleum and coal products and leather and leather products industries. The primary metals industry shows the highest elasticity of 1.4414, and the leather and leather products industry shows the lowest elasticity of 0.1867. The technological change variable is not statistically significant in most cases.

Decomposition of TFP Growth

In this section, we compare the relative importance of shifts in the cost function, returns to scale, and public capital investment on the measured total factor productivity. Based on (4.12), the growth rate of TFP, W, has three components, technological change, returns to scale, and public capital investment. In mathematics,

$$W = (1- \varepsilon_{cY})\left(\frac{d\log Y}{dT}\right) + \varepsilon_{cG}\left(\frac{d\log G}{dT}\right) + \varepsilon_{cT}. \qquad (4.12)$$

Then ε_{cT} can be calculated by a mathematical rearrangement using (4.6). Since the left-hand side of both (4.6) and (4.12) is W, W can be deleted, yielding:

$$- \varepsilon_{cT} = \varepsilon_{cY}\left(\frac{d\log Y}{dT}\right) + \varepsilon_{cG}\left(\frac{d\log G}{dT}\right) - \left(\frac{d\log F}{dT}\right). \qquad (5.5)$$

The required parameters are ε_{cY}, and ε_{cG}, which are taken from TABLES VIII and IX.

Then, ε_{cY}, ε_{cG} and ε_{cT} are obtained. Using (4.12), we can decompose the growth rate of TFP into three sources. The first one is the returns to scale, $(1- \varepsilon_{cY})\left(\frac{d\log Y}{dT}\right)$. The second one is the effect of public capital, $\varepsilon_{cG}\left(\frac{d\log G}{dT}\right)$, and the final term is the shift of cost function, ε_{cT}. All three terms will be added together, and divided by each term and multiplied by 100.

TABLES X and XI show the results of this calculation and the growth rate of TFP (calculated based on (4.6) and (4.9)) for individual industries and the total economy. According to these tables, some factors have negatively contributed to TFP growth in some industries. The significance of these results is uncertain for three reasons. First, the estimated coefficients are statistically insignificant for the mining, wholesale trade, leather and leather products and services industries. Second, the performance of the regression is very poor (R-squared is low) for both the wholesale trade and primary metal industries. Third, significant variation in the price of capital, mostly due to the large variation in the average effective tax rate, may have affected the performance of the regressions, and the credibility of the estimators. For example, during some periods, there were negative tax rates in primary metals, miscellaneous manufacturing, and motor vehicles and equipment industries ranging from -2.058 (in the primary metal industry) to -10.48276 (in the mining industry).

Returns to scale dominate other factors in explaining TFP growth in almost all industries. The highest contributions of returns to scale to TFP growth are in the transportation and public utilities, manufacturing, and services industries. One notable finding is that after 1975 the contribution of public capital to TFP growth dropped significantly, both in the total economy and in 5 out of 7 industries.

TABLE X

DECOMPOSITION OF TFP GROWTH

Industry	Period	TFP	Percentage contribution to TFP growth: Shifts of cost function	Returns to scale	Public capital
Total economy	1958-91	0.88%	21.67	56.71	21.62
	1958-75	0.59%	9.58	57.50	32.92
	1976-91	1.07%	29.25	56.19	14.56
Construc-tion	1958-91	3.81%	68.15	13.43	18.42
	1958-75	3.70%	54.69	17.18	28.13
	1976-91	3.92%	52.62	.32	47.06
Finance, insurance, and real estate	1958-91	-0.96%	29.35	47.39	23.26
	1958-75	-2.01%	22.59	11.50	65.91
	1976-91	.00%	9.93	56.21	33.86
Manufactur-ing	1958-91	0.52%	32.96	45.73	21.31
	1958-75	0.85%	24.94	48.42	26.64
	1976-91	0.17%	37.18	45.63	17.19
Mining	1958-91	0.35%	20.73	79.42	-.15
	1958-75	0.98%	34.50	168.85	-103.35
	1976-91	-0.36%	18.15	82.62	-.77

TABLE X (CONTINUED)

DECOMPOSITION OF TFP GROWTH

Industry	Period	TFP	Percentage contribution to TFP growth: Shifts of cost function	Returns to scale	Public capital
Wholesale trade	1958-91	0.49%	28.26	54.16	17.58
	1958-75	1.70%	-69.41	101.25	68.16
	1976-91	0.00%	52.15	44.79	3.06
Retail trade	1958-91	0.88%	20.00	55.44	24.56
	1958-75	1.48%	10.48	59.42	30.10
	1976-91	0.24%	39.42	49.56	11.02
Services	1965-91	3.00%	18.61	60.70	20.69
	1965-75	2.79%	-23.55	63.07	60.48
	1976-91	3.15%	36.30	59.11	4.59
Transportation and public utilities	1965-91	0.99%	34.12	54.41	11.47
	1965-75	-1.03%	33.94	47.80	18.26
	1976-91	2.38%	4.98	59.66	35.36

TABLE XI

DECOMPOSITION OF TFP GROWTH, MANUFACTURING, 1958-1991

		Percentage contribution to TFP growth		
Industry	TFP	Shifts of cost function	Returns to scale	Public capital
Apparel and other textile products	2.52%	21.69	31.52	46.79
Chemicals and allied products	0.01%	25.93	45.45	23.62
Food and kindred products	0.19%	21.32	53.12	25.56
Leather and leather products	2.26%	-7.98	68.72	39.26
Paper and allied products	0.03%	28.21	44.79	27.00
Machinery, except electrical	0.47%	21.16	81.03	-2.19
Electric and electronic equipment	0.29%	-19.39	56.53	62.86
Primary metal industries	1.69%	-47.56	93.79	53.77
Miscellaneous manufacturing industries	2.12%	-16.16	52.71	63.45
Motor vehicles and equipments	0.49%	-9.23	72.28	36.95

TABLE XI (CONTINUED)

DECOMPOSITION OF TFP GROWTH, MANUFACTURING, 1958-1991

		Percentage contribution to TFP growth		
Industry	TFP	Shifts of cost function	Returns to scale	Public capital
Fabricated metal products	0.83%	28.01	57.83	14.16
Furniture and fixtures	1.16%	9.54	54.40	36.06
Instruments and related products	0.40%	31.16	55.72	13.12
Lumber and wood products	3.17%	9.16	65.31	25.53
Petroleum and coal products	0.45%	27.51	52.01	20.48
Printing and publishing	1.08%	17.11	55.29	27.60
Rubber and miscellaneous plastic products	0.09%	9.09	43.39	47.52
Stone, clay, and glass products	0.70%	31.90	65.26	2.84
Textile mill products	1.08%	35.09	53.23	11.68
Tobacco manufactures	-1.35%	44.49	46.76	8.35

During this period, 1976-91, public capital investment declined significantly.

On average, the contribution of public capital to TFP growth is around 20 percent. For some sub-periods, the retail trade, transportation and public utilities, construction, and finance, insurance, and real estate industries have received a large contribution from public capital. Manufacturing industry has received a relatively consistent contribution from public capital.

Increasing returns to scale is the dominant contributor to TFP in most manufacturing industries. The lumber and wood products, stone, clay, and glass products, machinery-except-electrical industries received the higher contribution from returns to scale. The apparel and other textile products and rubber and miscellaneous plastic products industries have received higher contributions from public capital than other industries. The machinery-except-electrical, and stone, clay, and glass products industries have received relatively low contributions from public capital. On average, contribution of public capital to TFP growth is around 20 percent in the 20 manufacturing industries, also.

Comparisons To Other Studies

The results in this study are confirmed by some alternative approaches by other studies. Lynde and Richmond (1992) also found that public capital and private capital are complements in production for the U.S. economy from the period of 1958-89. Lynde and Richmond (1993) showed that 1 percent decline in U.S. labor productivity growth can be explained by the decrease of government capital-labor ratio, which is contributed for 41 percent. This result is much lower than Munnell's (1990) 78 percent. Morrison and Schwartz (1992) showed that infrastructure investment can save the costs of manufacturing industry by 15-30 percent in various regions. Nadiri and Mamuneas(1991)'s study found that the elasticity of infrastructure capital services to TFP growth is .292 in U.S. manufacturing industry for the period of 1956-86.

The results in this study are somewhat consistent with the results of Conrad and Seitz (1994), who employed a cost function approach using former West Germany data for the period of 1961-1988. What they found is that public infrastructure played a significant role in cost reduction in the manufacturing, trade and transport, and construction industries, thus contributing to TFP growth in those industries. They also found that public infrastructure was an important complement to private capital investment in the former West Germany.

Not many studies on the percentage contribution of public capital to TFP growth in specific industries, only Nadiri and Mamuneas (1991) shows some empirical analysis in manufacturing sector from 1956 to 1986. The labor productivity was decomposed into four sources, private inputs (K, L, intermediate), infrastructure, R&D, and technological change. What they found was that the contribution of infrastructure to labor productivity was fairly large during the period of 1969-79. On average, the percentage contribution of infrastructure was around 20 percent. In the period of 1979-86, the percentage contribution of infrastructure dropped significantly (less than 5 percent on average), which is consistent with this study.

CHAPTER VI

CONCLUSIONS AND SUGGESTIONS

This study is an attempt to determine the contribution that public capital investment has made in reducing costs in the private sector, and the relationship between public capital investment and private capital investment. We have modeled and measured the impacts of the effects of public capital investment on costs and productivity, and the relationships between the two types of capital inputs. The data set used covers the SIC two-digit manufacturing industries, the total economy, and the principal non-farm sectors, such as mining, retail trade, construction, etc., for the period of 1958 to 1991.

The empirical results indicate that public capital and private capital are complements, and public capital and labor are substitutes. Other results indicate that public capital is an important contributor to cost reduction, and, thus, productivity growth. Overall, a 1% increase in public capital reduces total cost in the economy by 0.3031%. Of all the industries examined, it appears that the manufacturing, transportation and public utilities and construction industries are most affected by public capital investment. Due to the reduction of public capital investment in the 1980s, the contribution of public capital to TFP growth was reduced in five out of seven industries.

Another contribution of this study is the calculation of the prices of public capital and private capital, and the average effective corporate tax rate, for individual industries for the study period.

The results of this study support the view that public capital plays a significant role in the nation's productivity trends and in observed patterns of cost reduction. Study findings also support the idea that public capital and private capital complement each other.

A desirable extension of this study is an analysis on the state, and the SMSA level. Public capital and private capital data are available for every state and SMSA. However, the price of public capital and private capital for every state and SMSA requires a lot of data sets, for example, the depreciation rate and interest rate across states and SMSAs. It could be difficult, but it appears not to be impossible, to obtain these data.

ENDNOTES

1 The first attempt to measure TFP was made by Tinbergen in 1942, and elaborated by Kendrick (1961). Denison (1962) expanded the effort further.

2. $(1.04)^{18}=2.02$

3. For more detail, see BLS (1988), pp.10-11, p.18.

4. This effect can be negative, if public and private capital are substitutes. That is, pubic capital crowds out private capital.

5. For more detail on the concept of optimal public investment, see Arrow and Kurz (1970)

6. For example, the efficiency criterion may not be the only proper guide for public capital provision. An equity criterion is sometimes more important in public choice decision-making.

7. See Musgrave (1992), p. 137

8. See Ekelund and Hebert (1983), p. 104.

9. For more detail, see Binswanger (1974).

10. For more detail, see Denny and Fuss (1979).

11. For the proof, see Binwanger (1974).

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APPENDIX

TABLE XII
AVERAGE EFFECTIVE CORPORATE TAX RATE

Year	Total economy	Construc -tion	Finance, insurance, and real estste	Manufactur -ing	Mining
1958	0.452677	0.463668	0.496304	0.471705	0.210682
1959	0.443016	0.503676	0.437747	0.470472	0.255495
1960	0.443801	0.602151	0.459798	0.470005	0.227758
1961	0.446625	0.531429	0.455343	0.484252	0.236479
1962	0.425277	0.437432	0.447607	0.458975	0.237467
1963	0.428870	0.421589	0.483233	0.460977	0.253802
1964	0.411490	0.359094	0.529886	0.437340	0.240037
1965	0.391743	0.337563	0.473639	0.420072	0.257393
1966	0.395572	0.358279	0.451680	0.425101	0.263388
1967	0.399083	0.360406	0.503873	0.420112	0.217579
1968	0.434622	0.364162	0.526894	0.466298	0.275550
1969	0.445550	0.392959	0.556426	0.483694	0.327143
1970	0.438270	0.401463	0.557089	0.482050	0.347000
1971	0.418905	0.405126	0.533285	0.460740	0.283616
1972	0.400553	0.418755	0.525568	0.451559	0.383792
1973	0.376437	0.430584	0.558729	0.429749	0.299053
1974	0.362647	0.413976	0.620570	0.413229	0.328493
1975	0.362578	0.414224	0.617214	0.419052	0.311960
1976	0.369667	0.378847	0.581062	0.435452	0.320749
1977	0.359285	0.310271	0.512159	0.434873	0.456259
1978	0.351070	0.289357	0.514374	0.412341	0.675900
1979	0.336603	0.333709	0.576863	0.393689	0.469241
1980	0.351979	0.356891	0.750625	0.418254	0.296792
1981	0.354479	0.460886	0.987161	0.372462	0.769019
1982	0.357811	0.463884	1.367778	0.382664	-0.231297
1983	0.366530	0.580009	0.822575	0.428871	-0.047758
1984	0.391031	0.442602	1.197889	0.438440	-0.321903
1985	0.428877	0.374250	1.081289	0.413944	-0.034045
1986	0.488865	0.312275	1.012192	0.597677	-0.051307
1987	0.441474	0.253885	0.976353	0.464673	-0.573034
1988	0.394233	0.221053	0.912780	0.409572	2.545073
1989	0.412044	0.226940	0.918494	0.439118	1.551425
1990	0.379122	0.202500	0.762373	0.412171	0.727945
1991	0.358160	0.213143	0.648974	0.423231	-10.48276

TABLE XII (CONTINUED)
AVERAGE EFFECTIVE CORPORATE TAX RATE

Year	Retail	Services	Transportation and public utilities	Wholesale
1958	0.487190	0.559775	0.535429	0.472144
1959	0.451330	0.518124	0.523736	0.442172
1960	0.464632	0.521265	0.519744	0.442676
1961	0.402427	0.566441	0.532209	0.445840
1962	0.393452	0.544653	0.498761	0.431478
1963	0.397148	0.502722	0.485989	0.425718
1964	0.352295	0.418021	0.462300	0.386032
1965	0.336795	0.392557	0.435092	0.378818
1966	0.350019	0.369985	0.435576	0.372072
1967	0.351926	0.365256	0.447914	0.381257
1968	0.376558	0.417096	0.499545	0.412642
1969	0.386958	0.500485	0.502753	0.410522
1970	0.374654	0.527455	0.512545	0.396949
1971	0.374643	0.473758	0.455745	0.396669
1972	0.387104	0.409643	0.411223	0.321458
1973	0.375237	0.348195	0.406785	0.311450
1974	0.349904	0.350463	0.380844	0.295827
1975	0.366738	0.321469	0.295382	0.276353
1976	0.358797	0.300156	0.273486	0.285202
1977	0.340633	0.271145	0.267529	0.275474
1978	0.344913	0.288538	0.275475	0.265584
1979	0.350433	0.298832	0.275736	0.256825
1980	0.364963	0.293251	0.278063	0.264979
1981	0.376242	0.283862	0.260899	0.257107
1982	0.340709	0.225945	0.223693	0.248906
1983	0.348084	0.293252	0.262178	0.253216
1984	0.355594	0.329266	0.278149	0.260784
1985	0.353697	0.347981	0.330971	0.413512
1986	0.402905	0.304323	0.414348	0.407227
1987	0.384676	0.347417	0.454354	0.358878
1988	0.369574	0.326103	0.422782	0.274966
1989	0.376506	0.368016	0.467285	0.288210
1990	0.372997	0.261313	0.449873	0.158238
1991	0.317777	0.217188	0.398412	0.273610

TABLE XII (CONTINUED)
AVERAGE EFFECTIVE CORPORATE TAX RATE

Year	Electric and electronic equipment	Fabricated metal products	Furniture and fixtures	Instruments and related products	Lumber and wood products
1958	0.517584	0.524505	0.566879	0.532000	0.328877
1959	0.533295	0.516934	0.550459	0.530643	0.314442
1960	0.563413	0.534404	0.565934	0.547967	0.277612
1961	0.585913	0.523576	0.545000	0.548387	0.270349
1962	0.543151	0.470100	0.494024	0.528378	0.227876
1963	0.537922	0.462991	0.472924	0.508197	0.226481
1964	0.537260	0.449130	0.435737	0.506373	0.211594
1965	0.474046	0.428980	0.431235	0.475694	0.204276
1966	0.471722	0.426107	0.458333	0.480439	0.226087
1967	0.480226	0.440898	0.425532	0.500000	0.222222
1968	0.540851	0.498637	0.469136	0.548728	0.267755
1969	0.605437	0.494697	0.519115	0.551032	0.253828
1970	0.689087	0.552030	0.511561	0.545085	0.273292
1971	0.606166	0.503207	0.490814	0.549663	0.276954
1972	0.534736	0.449066	0.477528	0.535100	0.321452
1973	0.516844	0.413388	0.463221	0.538561	0.342271
1974	0.598165	0.430805	0.455206	0.543201	0.327947
1975	0.497564	0.455278	0.480000	0.520703	0.261444
1976	0.576415	0.457155	0.458746	0.519012	0.271799
1977	0.476221	0.441509	0.439735	0.517181	0.294364
1978	0.452624	0.420743	0.444324	0.514412	0.264742
1979	0.470918	0.405276	0.457173	0.533849	0.236775
1980	0.443534	0.445080	0.495972	0.553309	0.230672
1981	0.458639	0.471090	0.483978	0.481004	-3.978261
1982	1.269113	0.610673	0.437500	0.624913	-0.024590
1983	0.684827	0.572329	0.449173	0.505376	0.260913
1984	0.660511	0.490767	0.496979	0.520665	0.257069
1985	0.977960	0.447182	0.468561	0.637122	0.347029
1986	0.949615	0.460990	0.494754	0.921852	0.326870
1987	0.476330	0.399394	0.419299	0.717110	0.278478
1988	0.492806	0.300946	0.397761	0.491653	0.300209
1989	0.478691	0.314793	0.491493	0.436786	0.305460
1990	0.514849	0.311250	0.407451	0.315044	0.318145

TABLE XII (CONTINUED)
AVERAGE EFFECTIVE CORPORATE TAX RATE

Year	Machinery, except electrical	Primary metal industries	Miscellaneous manufacturing industries	Motor vehicles and equipments	Stone, clay, and glass products
1958	0.572868	0.496030	0.515528	0.567173	0.434171
1959	0.527125	0.486975	0.502488	0.539164	0.454475
1960	0.540992	0.475743	0.514019	0.552804	0.469565
1961	0.543767	0.531710	0.528409	0.557679	0.484880
1962	0.551028	0.443850	0.498783	0.522397	0.457023
1963	0.493390	0.440506	0.496314	0.521271	0.529304
1964	0.476769	0.409020	0.451991	0.492879	0.418026
1965	0.451183	0.395656	0.413861	0.473635	0.409402
1966	0.477441	0.399279	0.428843	0.464859	0.412500
1967	0.390165	0.382734	0.421348	0.470145	0.418497
1968	0.532159	0.395934	0.489583	0.505594	0.441683
1969	0.542493	0.446145	0.539568	0.549373	0.472711
1970	0.541911	0.466667	0.496124	0.881361	0.453659
1971	0.522760	0.377551	0.578512	0.505941	0.418564
1972	0.487973	0.397569	0.480742	0.490822	0.407857
1973	0.480675	0.375252	0.449886	0.491184	0.374181
1974	0.474376	0.368967	0.457995	0.553087	0.355263
1975	0.459795	0.384240	0.446215	0.542054	0.371283
1976	0.505529	0.356734	0.472441	0.503394	0.383957
1977	0.470065	0.531646	0.459330	0.529685	0.382190
1978	0.445122	0.382949	0.460015	0.543138	0.427928
1979	0.440299	0.348056	0.477446	0.664606	0.360616
1980	0.436024	0.433728	0.552773	-0.100314	0.392168
1981	0.440809	0.409585	0.521708	-0.297174	0.509029
1982	0.705100	-0.025787	0.562236	-0.002984	-0.144558
1983	0.724791	0.040688	2.280423	0.276852	0.648900
1984	0.632841	-2.058011	0.628508	0.307147	0.438686
1985	0.476727	-0.400000	0.610954	0.242761	0.435100
1986	0.816568	0.644362	0.664694	0.279818	0.383953
1987	0.375000	0.253946	0.524766	0.438473	0.505043
1988	0.262478	0.222508	0.438894	0.514005	0.549333
1989	0.274976	0.287068	0.424805	0.802554	0.599066
1990	0.222720	0.422138	0.345819	1.091795	0.531915

TABLE XII (CONTINUED)
AVERAGE EFFECTIVE CORPORATE TAX RATE

Year	Apparel and other textile products	Chemicals and allied products	Food and kindred products	Leather and leather products	Paper and allied products
1958	0.466387	0.520245	0.508165	0.496183	0.512009
1959	0.465798	0.516969	0.508217	0.479042	0.494392
1960	0.476667	0.508217	0.503218	0.507246	0.486564
1961	0.480226	0.521176	0.509037	0.518248	0.484190
1962	0.448931	0.514321	0.487427	0.474684	0.468938
1963	0.472941	0.505655	0.477491	0.457627	0.434955
1964	0.436433	0.480831	0.467290	0.430769	0.409091
1965	0.419458	0.452152	0.450149	0.415584	0.396226
1966	0.398136	0.448882	0.459246	0.421875	0.394980
1967	0.445893	0.463894	0.459052	0.417857	0.369397
1968	0.483653	0.516337	0.513031	0.482315	0.403413
1969	0.499373	0.532139	0.526316	0.542373	0.398463
1970	0.489218	0.520256	0.508347	0.637306	0.396552
1971	0.470309	0.495561	0.479310	0.525424	0.393238
1972	0.393686	0.478767	0.486197	0.511013	0.384856
1973	0.437233	0.466358	0.465951	0.515982	0.389283
1974	0.470206	0.483055	0.482631	0.500000	0.418377
1975	0.417981	0.479972	0.447559	0.474320	0.388440
1976	0.448468	0.467269	0.457045	0.423372	0.387255
1977	0.462507	0.488297	0.463945	0.496437	0.369079
1978	0.415366	0.482215	0.452542	0.495560	0.378031
1979	0.453496	0.448775	0.456357	0.475548	0.344067
1980	0.443963	0.477084	0.485549	0.466840	0.341113
1981	0.450939	0.399840	0.437711	0.482213	0.340378
1982	0.400806	0.554910	0.598067	0.467133	0.294594
1983	0.416192	0.553120	0.456480	0.435691	0.385152
1984	0.471698	0.481332	0.490676	0.418219	0.363999
1985	0.575660	0.597170	0.584217	0.436464	0.348449
1986	0.432182	0.618399	0.533793	0.728814	0.305206
1987	0.307036	0.458796	0.474322	0.319372	0.352687
1988	0.296013	0.380059	0.447747	0.305419	0.313357
1989	0.282027	0.380262	0.605817	0.280612	0.325594
1990	0.283316	0.424748	0.413016	0.224490	0.331506

TABLE XII (CONTINUED)
AVERAGE EFFECTIVE CORPORATE TAX RATE

Year	Petroleum and coal products	Printing and publishing	Rubber and miscellaneous plastic products	Textile mill products	Tobacco manufact-ures
1958	0.080764	0.555072	0.525060	0.524941	0.529750
1959	0.119810	0.491684	0.532197	0.470511	0.530541
1960	0.107448	0.492114	0.517241	0.506006	0.526050
1961	0.107159	0.506011	0.533473	0.507614	0.530769
1962	0.080258	0.485915	0.480080	0.477273	0.526480
1963	0.136448	0.489459	0.492063	0.484890	0.526003
1964	0.102564	0.454874	0.464029	0.465479	0.506977
1965	0.140919	0.436697	0.442810	0.439823	0.496894
1966	0.200591	0.427810	0.440860	0.438017	0.494083
1967	0.176516	0.443407	0.445816	0.449571	0.497914
1968	0.164380	0.492593	0.473573	0.501718	0.549738
1969	0.150999	0.497039	0.474157	0.523763	0.540842
1970	0.198438	0.463728	0.508368	0.519016	0.520742
1971	0.197659	0.464304	0.480392	0.489840	0.502000
1972	0.234317	0.460106	0.453172	0.484645	0.511135
1973	0.222949	0.448529	0.404202	0.464231	0.529271
1974	0.223677	0.431869	0.386965	0.566239	0.471302
1975	0.249975	0.422287	0.410714	0.543243	0.498726
1976	0.297273	0.453901	0.447853	0.469565	0.521614
1977	0.262941	0.448071	0.419576	0.474368	0.530362
1978	0.230062	0.440115	0.413814	0.425397	0.476979
1979	0.264878	0.417240	0.412269	0.455294	0.483746
1980	0.290432	0.410313	0.479381	0.568450	0.438032
1981	0.182963	0.402941	0.433225	0.442177	0.496742
1982	0.147137	0.395506	0.391944	0.473568	0.506416
1983	0.230497	0.427003	0.365915	0.446771	0.470930
1984	0.269695	0.450341	0.368254	0.515152	0.559768
1985	0.177661	0.421857	0.328033	0.526749	0.466105
1986	-0.039408	0.475869	0.437819	0.434521	0.402333
1987	-1.233586	0.418006	0.467565	0.369020	0.487119
1988	0.549824	0.468486	0.368868	0.479554	0.466775
1989	0.844833	0.473565	0.296312	0.432243	0.511838
1990	0.421332	0.450228	0.320499	0.363248	0.418023

TABLE XIII
PRICE OF PUBLIC CAPITAL AND PRIVATE CAPITAL

Year	Construction	Total economy	
	PK	PG	PK
1958	0.714934	0.472812	0.690151
1959	0.742937	0.480691	0.693832
1960	0.809505	0.476171	0.689065
1961	0.771006	0.473732	0.688123
1962	0.723673	0.474180	0.678664
1963	0.705552	0.475876	0.681996
1964	0.658223	0.479430	0.677992
1965	0.651817	0.485523	0.676752
1966	0.669652	0.501102	0.699204
1967	0.693743	0.512775	0.719306
1968	0.734146	0.539234	0.776176
1969	0.872884	0.568693	0.822876
1970	0.833961	0.602646	0.870246
1971	0.871182	0.635521	0.910340
1972	0.914704	0.681526	0.962448
1973	0.950330	0.739220	1.021004
1974	1.099991	0.849204	1.162732
1975	1.247379	0.933777	1.282279
1976	1.307393	0.996801	1.377693
1977	1.353697	1.076998	1.474134
1978	1.466557	1.184952	1.605442
1979	1.715098	1.309807	1.751765
1980	2.011650	1.468877	1.992998
1981	2.427206	1.631882	2.211666
1982	2.619007	1.701207	2.321911
1983	2.921979	1.718935	2.368371
1984	2.727707	1.770765	2.471265
1985	2.613061	1.780386	2.563598
1986	2.531156	1.803391	2.709498
1987	2.460206	1.858233	2.701233
1988	2.464524	1.947450	2.735487
1989	2.561948	2.191435	3.105310
1990	2.603068	2.307875	3.198060
1991	2.748334	2.369742	3.233657

TABLE XIII (CONTINUED)
PRICE OF PUBLIC CAPITAL AND PRIVATE CAPITAL

Year	Wholesale	Transportation and public utilities
	PK	PK
1958	0.749640	0.806099
1959	0.732358	0.810691
1960	0.709372	0.805701
1961	0.712181	0.806911
1962	0.690290	0.788999
1963	0.689906	0.783598
1964	0.670221	0.777911
1965	0.660626	0.775385
1966	0.679616	0.794871
1967	0.703498	0.827758
1968	0.764248	0.894233
1969	0.806908	0.938465
1970	0.855637	1.004808
1971	0.901531	1.021776
1972	0.893003	1.067295
1973	0.945783	1.150140
1974	1.069239	1.299388
1975	1.148382	1.358331
1976	1.237933	1.429562
1977	1.328066	1.506766
1978	1.441930	1.633904
1979	1.579239	1.789680
1980	1.775972	1.988964
1981	1.932432	2.153851
1982	1.992089	2.202752
1983	2.006678	2.319563
1984	2.022814	2.413303
1985	2.264293	2.521940
1986	2.284540	2.686757
1987	2.291648	2.834192
1988	2.258290	2.926586
1989	2.345048	3.129119
1990	2.171406	3.180845
1991	2.475518	3.125205

TABLE XIII (CONTINUED)
PRICE OF PUBLIC CAPITAL AND PRIVATE CAPITAL

Year	Retail	Services
	PK	PK
1958	0.773954	0.766724
1959	0.738973	0.742310
1960	0.722933	0.727396
1961	0.680836	0.742419
1962	0.669794	0.730038
1963	0.669215	1.374702
1964	0.645261	0.667953
1965	0.636846	1.189090
1966	0.659086	0.681140
1967	0.668335	0.699897
1968	0.717074	0.762550
1969	0.761952	0.847444
1970	0.802554	0.920015
1971	0.854682	0.939782
1972	0.918280	0.944675
1973	0.980520	0.965706
1974	1.092561	1.099612
1975	1.188944	1.179772
1976	1.256192	1.242358
1977	1.348202	1.317297
1978	1.500082	1.472883
1979	1.660926	1.648530
1980	1.876624	1.851327
1981	2.070224	2.037253
1982	2.111316	2.058555
1983	2.173676	2.210572
1984	2.241304	2.319659
1985	2.265262	2.368937
1986	2.391277	2.328134
1987	2.446400	2.457617
1988	2.520141	2.501120
1989	2.589150	2.651983
1990	2.640952	2.515203
1991	2.572025	2.475670

TABLE XIII (CONTINUED)
PRICE OF PUBLIC CAPITAL AND PRIVATE CAPITAL

Year	Mining	Finance, insurance, and real estate
	PK	PK
1958	0.477558	0.659426
1959	0.521038	0.622942
1960	0.500668	0.616742
1961	0.512227	0.608110
1962	0.518785	0.599929
1963	0.520280	0.616027
1964	0.526515	0.636339
1965	0.554211	0.619142
1966	0.587683	0.632060
1967	0.591544	0.668211
1968	0.661607	0.723057
1969	0.733018	0.785645
1970	0.787394	0.840466
1971	0.803314	0.890789
1972	1.008182	0.952886
1973	1.061577	1.063341
1974	1.310010	1.255287
1975	1.464524	1.357873
1976	1.603443	1.420120
1977	1.985171	1.473542
1978	2.567730	1.630432
1979	2.454875	1.878566
1980	2.536972	2.327230
1981	4.047269	2.884427
1982	1.735687	3.588901
1983	1.974207	2.819881
1984	1.410251	3.492213
1985	2.028071	3.346765
1986	1.949905	3.289162
1987	0.902469	3.332514
1988	8.358402	3.363344
1989	6.432125	3.490149
1990	4.629283	3.313938
1991	-26.22149	3.146556

TABLE XIII (CONTINUED)
PRICE OF PUBLIC CAPITAL AND PRIVATE CAPITAL

Year	Manufacturing	Morrison and Schwartz
	PK	PK
1958	0.645673	
1959	0.666411	
1960	0.669728	
1961	0.680360	
1962	0.677704	
1963	0.686990	
1964	0.684884	
1965	0.684356	
1966	0.708352	
1967	0.721617	
1968	0.784090	
1969	0.828629	
1970	0.877338	
1971	0.913144	1.257
1972	0.954613	1.229
1973	1.010405	1.267
1974	1.151764	1.641
1975	1.286020	1.864
1976	1.381848	1.887
1977	1.495207	1.935
1978	1.616417	2.227
1979	1.761373	2.483
1980	2.021564	3.208
1981	2.156441	3.973
1982	2.283717	4.282
1983	2.424099	3.894
1984	2.526551	4.085
1985	2.537127	3.971
1986	2.980650	3.739
1987	2.840339	3.919
1988	2.855401	
1989	3.015362	
1990	3.049949	
1991	3.094741	

TABLE XIII (CONTINUED)
PRICE OF PUBLIC CAPITAL AND PRIVATE CAPITAL

Year	Apparel and other textile products	Chemicals and allied products
	PK	PK
1958	0.689049	0.699569
1959	0.639298	0.730355
1960	0.644141	0.725022
1961	0.658626	0.723262
1962	0.642267	0.734201
1963	0.643788	0.736811
1964	0.633383	0.731152
1965	0.601460	0.714536
1966	0.655189	0.726120
1967	0.688747	0.744730
1968	0.748562	0.805764
1969	0.849609	0.851327
1970	0.873549	0.898967
1971	0.880043	0.936272
1972	0.841414	0.980190
1973	0.957572	1.052939
1974	1.133455	1.228143
1975	1.226075	1.365871
1976	1.318841	1.432757
1977	1.484271	1.559561
1978	1.540865	1.692956
1979	1.804050	1.813788
1980	2.026446	2.079748
1981	2.228310	2.188238
1982	2.269245	2.566104
1983	2.411251	2.641978
1984	2.630603	2.628987
1985	2.819761	2.907245
1986	2.708504	3.060642
1987	2.532136	2.857583
1988	2.654394	2.809224
1989	2.688423	2.888506
1990	2.731431	3.044909
1991	2.821311	3.002815

TABLE XIII (CONTINUED)
PRICE OF PUBLIC CAPITAL AND PRIVATE CAPITAL

Year	Fabricated metal	Food and kindred products
	PK	PK
1958	0.643733	0.707715
1959	0.662123	0.722105
1960	0.684236	0.717828
1961	0.681634	0.724032
1962	0.680101	0.718127
1963	0.686287	0.718164
1964	0.691323	0.720556
1965	0.696309	0.725138
1966	0.713762	0.759480
1967	0.734227	0.783981
1968	0.794670	0.828440
1969	0.817525	0.905986
1970	0.895921	0.946583
1971	1.061938	0.971095
1972	0.921822	1.013965
1973	0.955243	1.074140
1974	1.119751	1.253881
1975	1.262854	1.341045
1976	1.329346	1.422549
1977	1.432815	1.522807
1978	1.548265	1.662027
1979	1.706344	1.847492
1980	2.002045	2.121220
1981	2.242672	2.265731
1982	2.607495	2.629978
1983	2.618726	2.465262
1984	2.582526	2.631233
1985	2.589206	2.868263
1986	2.732242	2.901635
1987	2.726670	2.905324
1988	2.673750	2.963105
1989	2.822142	3.401530
1990	2.946446	3.082339
1991	3.035268	3.073670

TABLE XIII (CONTINUED)
PRICE OF PUBLIC CAPITAL AND PRIVATE CAPITAL

Year	Leather and leather products	Lumber and wood products
	PK	PK
1958	0.653372	0.571998
1959	0.750095	0.574064
1960	0.764503	0.552761
1961	0.769873	0.566664
1962	0.645690	0.557937
1963	0.615693	0.558927
1964	0.604777	0.556978
1965	0.827065	0.559275
1966	0.752507	0.584749
1967	0.661997	0.614660
1968	0.821956	0.674270
1969	0.859115	0.696897
1970	1.014135	0.761494
1971	0.941531	0.796117
1972	1.087018	0.862717
1973	1.124701	0.928920
1974	1.439275	1.055836
1975	1.416551	1.092014
1976	1.516392	1.185314
1977	1.800711	1.296849
1978	1.822447	1.415642
1979	1.958657	1.549969
1980	2.311036	1.775850
1981	2.266540	-4.795027
1982	2.363303	1.681317
1983	2.506891	2.275711
1984	2.484980	2.376278
1985	2.747977	2.635421
1986	3.522577	2.691392
1987	2.693061	2.698441
1988	2.889683	2.811685
1989	2.977565	2.900518
1990	2.847892	3.007591
1991	3.083155	3.056034

TABLE XIII (CONTINUED)
PRICE OF PUBLIC CAPITAL AND PRIVATE CAPITAL

Year	Machinery, except electrical	Electric and electronic equipment
	PK	PK
1958	0.685563	0.682705
1959	0.701908	0.705689
1960	0.722660	0.730686
1961	0.731829	0.726792
1962	0.753239	0.719909
1963	0.738354	0.720437
1964	0.751589	0.718134
1965	0.759182	0.692924
1966	0.804064	0.708916
1967	0.781868	0.718613
1968	0.900479	0.787975
1969	0.927729	0.853558
1970	0.981948	0.959687
1971	1.019546	0.960338
1972	1.043915	0.969502
1973	1.096177	1.007194
1974	1.243168	1.221128
1975	1.354744	1.299289
1976	1.467146	1.476288
1977	1.549325	1.508596
1978	1.639580	1.615186
1979	1.772020	1.775104
1980	1.970481	1.931664
1981	2.172037	2.151685
1982	2.681188	3.472947
1983	2.762094	2.622084
1984	2.679270	2.640100
1985	2.474512	3.176230
1986	3.158993	3.201367
1987	2.485556	2.538163
1988	2.395914	2.686139
1989	2.511839	2.754515
1990	2.487617	2.921864
1991	2.524585	2.976295

TABLE XIII (CONTINUED)
PRICE OF PUBLIC CAPITAL AND PRIVATE CAPITAL

Year	Primary metal industries	Instruments and related products
	PK	PK
1958	0.628988	0.661955
1959	0.645828	0.657368
1960	0.640227	0.666095
1961	2.752916	0.637635
1962	0.646275	0.638427
1963	0.655019	0.632584
1964	0.648483	0.668311
1965	0.651559	0.652308
1966	0.676509	0.677720
1967	0.686466	0.704251
1968	0.726237	0.746520
1969	0.791238	0.800907
1970	0.855320	0.837888
1971	0.851034	0.908660
1972	0.911897	0.962475
1973	0.964910	1.039990
1974	1.119158	1.200881
1975	1.266765	1.312557
1976	1.318582	1.384606
1977	1.621055	1.507586
1978	1.612816	1.654531
1979	1.749068	1.852931
1980	2.126186	2.096977
1981	2.328985	2.165967
1982	1.722056	2.511410
1983	0.291342	2.375537
1984	-2.025429	2.442372
1985	1.191721	2.666679
1986	3.479098	3.220789
1987	2.795846	2.984094
1988	2.872854	2.716344
1989	3.172596	2.690218
1990	3.665531	2.536191
1991	3.728595	2.557563

TABLE XIII (CONTINUED)
PRICE OF PUBLIC CAPITAL AND PRIVATE CAPITAL

Year	Motor vehicles and equipment (other transportation equipment)	Miscellaneous manufacturing industries
	PK	PK
1958	0.669672	0.722173
1959	0.691288	0.728111
1960	0.722935	0.782968
1961	0.754484	0.750604
1962	0.753770	0.718779
1963	0.751679	0.771045
1964	0.704551	0.798575
1965	0.706439	0.787762
1966	0.723328	0.782504
1967	0.738605	0.796510
1968	0.799486	0.821594
1969	0.861880	0.896561
1970	1.107223	0.913180
1971	0.934706	1.026712
1972	0.976619	0.968391
1973	1.030551	1.036511
1974	1.276952	1.193871
1975	1.424289	1.289116
1976	1.488274	1.398424
1977	1.659610	1.495719
1978	1.837417	1.637687
1979	2.176535	1.861997
1980	1.329500	2.165922
1981	0.975496	2.391801
1982	1.684098	2.611725
1983	2.223767	5.585347
1984	2.340672	2.896739
1985	2.254965	2.999949
1986	2.373733	3.283774
1987	2.739227	3.121663
1988	3.037184	3.051008
1989	3.747411	3.075071
1990	4.490300	2.993565
1991	4.523591	3.032337

TABLE XIII (CONTINUED)
PRICE OF PUBLIC CAPITAL AND PRIVATE CAPITAL

Year	Paper and allied products	Petroleum and coal products
	PK	PK
1958	0.652113	0.439797
1959	0.664630	0.463429
1960	0.669161	0.464094
1961	0.670036	0.469826
1962	0.668163	0.467590
1963	0.667279	0.512743
1964	0.655477	0.507092
1965	0.652351	0.543309
1966	0.662897	0.596773
1967	0.669143	0.603319
1968	0.724091	0.631926
1969	0.766408	0.666006
1970	0.814976	0.730636
1971	0.867438	0.780823
1972	0.913390	0.863048
1973	0.988655	0.927916
1974	1.178673	1.048275
1975	1.282935	1.153811
1976	1.359317	1.245349
1977	1.438668	1.314929
1978	1.572420	1.421103
1979	1.675407	1.610805
1980	1.878962	1.840943
1981	2.094633	1.829054
1982	2.132097	1.816863
1983	2.328397	1.990519
1984	2.378994	2.144503
1985	2.390988	2.065570
1986	2.403512	1.779387
1987	2.604475	-0.458657
1988	2.632191	3.251353
1989	2.736278	4.071436
1990	2.830859	3.269762
1991	2.858330	3.270277

TABLE XIII (CONTINUED)
PRICE OF PUBLIC CAPITAL AND PRIVATE CAPITAL

Year	Printing and publishing	Rubber and miscellaneous plastic products
	PK	PK
1958	0.617409	0.650786
1959	0.628576	0.640348
1960	0.622661	0.660007
1961	0.622534	0.652432
1962	0.629979	0.630859
1963	0.636286	0.646602
1964	0.644353	0.660345
1965	0.647279	0.650534
1966	0.663255	0.676601
1967	0.691000	0.692627
1968	0.753505	0.743477
1969	0.794580	0.761070
1970	0.825580	0.839240
1971	0.867419	0.867573
1972	0.908974	0.891152
1973	0.974819	0.911962
1974	1.138356	1.054733
1975	1.256438	1.200109
1976	1.399580	1.320805
1977	1.501384	1.431129
1978	1.654309	1.574842
1979	1.814422	1.751096
1980	2.018917	2.116775
1981	2.215588	2.278054
1982	2.290378	2.334527
1983	2.404680	2.378442
1984	2.507046	2.445522
1985	2.473863	2.406517
1986	2.632884	2.705241
1987	2.577163	2.856905
1988	2.730390	2.754130
1989	2.787084	2.662902
1990	2.788779	2.781141
1991	2.796429	2.804845

TABLE XIII (CONTINUED)
PRICE OF PUBLIC CAPITAL AND PRIVATE CAPITAL

Year	Textile mill products	Stone, clay and glass products
	PK	PK
1958	0.745524	0.607001
1959	0.741349	0.629790
1960	0.779382	0.627346
1961	0.798682	0.649003
1962	0.768275	0.634317
1963	0.783802	0.684014
1964	0.768616	0.649978
1965	0.728441	0.654930
1966	0.720487	0.680168
1967	0.735865	0.707814
1968	0.787824	0.771658
1969	0.825900	0.826988
1970	0.853248	0.871160
1971	0.884772	0.896865
1972	0.904239	0.925164
1973	0.968350	0.963328
1974	1.222107	1.103171
1975	1.358512	1.242833
1976	1.397648	1.349414
1977	1.515385	1.487090
1978	1.636296	1.704832
1979	1.905864	1.811868
1980	2.354641	2.117246
1981	2.399097	2.584263
1982	2.604329	1.557667
1983	2.650550	3.142586
1984	2.885021	2.854945
1985	3.004744	2.926301
1986	2.988013	2.955954
1987	2.998570	3.327889
1988	3.322676	3.593557
1989	3.337546	3.819365
1990	3.257869	3.743835
1991	3.306853	3.780555

TABLE XIII (CONTINUED)
PRICE OF PUBLIC CAPITAL AND PRIVATE CAPITAL

Year	Furniture and fixtures	Tobacco manufactures
	PK	PK
1958	0.722972	0.644616
1959	0.717507	0.862513
1960	0.672652	0.777580
1961	0.774029	0.710277
1962	0.709827	0.732062
1963	0.677173	0.837564
1964	0.673664	0.762605
1965	0.703573	0.652983
1966	0.680677	0.733367
1967	0.678236	0.709569
1968	0.750496	0.808412
1969	0.799909	0.892130
1970	0.848775	0.885612
1971	0.882665	0.948369
1972	0.921108	0.973152
1973	0.992582	1.044635
1974	1.120671	1.179823
1975	1.282761	1.256333
1976	1.337922	1.394714
1977	1.409938	1.534650
1978	1.578721	1.627968
1979	1.750438	1.810935
1980	2.045808	1.928338
1981	2.257203	2.070765
1982	2.309692	2.154499
1983	2.398954	2.130700
1984	2.537594	2.313372
1985	2.541159	2.248928
1986	2.661212	2.245968
1987	2.606117	2.466891
1988	2.692895	2.652834
1989	2.957007	2.851542
1990	2.832709	2.856357
1991	2.928142	2.993879

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