

**Private and Public Investment Linkages:  
Some Evidence Using Sectoral Level Data**



**Umbreen Zahra**

**311-FE/MS ECO (2)/F12**

**Supervisor: Dr. Hajra Ihsan**

**Assistant Professor, IIE**

**Co-Supervisor: Dr. Abdul Rashid**

**Associate Professor, IIE**

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**Department of Economics**

**International Institute of Islamic Economics (IIE),**

**International Islamic University (IIU), Islamabad, Pakistan**



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Some Evidence Using Sectoral Level Data**

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بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

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*In the name of Allah, The most Gracious,  
The most merciful.*

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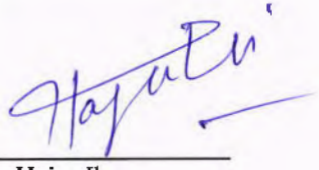
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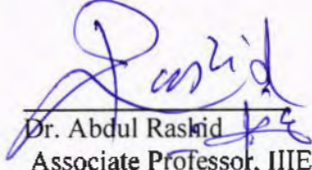
Accepted by the International Institute of Islamic Economics, International Islamic University, Islamabad, as partial fulfillment of the requirements for the award of degree of MS in Economics.

**Supervisor:**



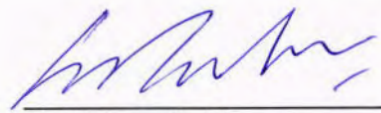
Dr. Hajra Ihsan  
Assistant Professor, IIIE  
International Islamic University Islamabad

**Co-Supervisor:**



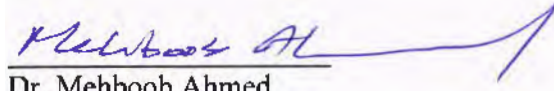
Dr. Abdul Rashid  
Associate Professor, IIIE  
International Islamic University Islamabad

**Internal Examiner:**

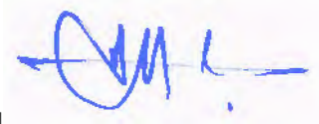


Dr. Faiz-ur-Rahim  
Assistant Professor, IIIE  
International Islamic University, Islamabad

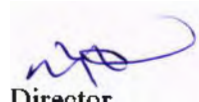
**External Examiner:**



Dr. Mehboob Ahmed  
Professor  
SZABIST, Islamabad



Head  
School of Economics, IIIE  
International Islamic University, Islamabad



Director  
International Institute of Islamic Economics  
International Islamic University, Islamabad

Date of Viva Voce: 12-05-2016

## **Dedication**

### **Dedicated to My Parents**

*You are both special in every way,  
Encouraging me more and more each passing day.*

*You both are the reason why I'm so strong,  
With you two at the helm not a thing could go wrong.*

*You've both helped me through many trials and tribulations,  
You've made things better in every situation.*

*Thank you both for always being there,  
And showing me that you truly care.*

*Words could never explain how I feel about you,  
But I hope you know that I truly love you two!*

## **Declaration**

I hereby declare that this thesis, neither as a whole nor as a part thereof, has been copied out from any source. It is further declared that I have carried out this research by myself and have completed this thesis on the basis of my personal efforts under the guidance and help of my supervisors. If any part of this thesis is proven to be copied out or earlier submitted, I shall stand by the consequences. No portion of work presented in this thesis has been submitted in support of any application for any other degree or qualification in International Islamic University or any other university or institute of learning.

**Umbreen Zahra**

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## Abstract

This study aims to empirically analyze the linkages between public investment and private investment at aggregate level as well as sectoral level. The sectors included in the study are Transport and Communication, Mining and Quarrying, Manufacturing, Finance, Construction and Agriculture sector in Pakistan. The analysis is based on annual time series data covering the period 1971-2013, except for the Agriculture sector. In case of Agriculture sector the data used are from the period 1981-2013 as data for previous years is not available from any published source. The multivariate cointegration approach is used to examine the existence of long run relationship between public and private investment. The results indicate that at aggregate level as well as sectoral level the public investment has positive and significant long run relationship with private investment except for Finance sector. In Finance sector, the relationship is positive but insignificant.

Variance decomposition for private investment indicate that the public investment is relatively less important variables in explaining forecast error variance of private investment at aggregate as well as at sectoral level. Impulse response functions show that, at aggregate level as in three sectors (Transport and Communication, Mining and Quarrying and Construction) one standard deviation shock in public investment shows significant crowding in effect. However, in remaining three sectors (Manufacturing, Finance and Agriculture) crowding out effect is apparent. The results of vector error correction model, in general, show significant error correction terms implying existence of significant long run relationship between public and private investment except for Finance sector which shows insignificant adjustment term. Further, results exhibit existence of significant positive short run relationship between public and private investment in four sectors (Transport and Communication, Mining and Quarrying, Manufacturing and Agriculture). This study is helpful for the policy makers in designing the investment policies. The finding of our study suggests that public investment complement private investment at aggregate level as well as at sectoral level.

**Key words:** Public and Private Investment, Crowding in, Crowding out, Johansen cointegration and Vector error correction model.

# **Chapter 1**

## **Introduction**

The main purpose of this thesis is to investigate the link between public investment and private investment at aggregate level as well as at different sector of the economy of Pakistan. These sectors are Transport and Communication sector, Mining and Quarrying sector, Manufacturing sector, Finance sector, Construction sector and Agriculture sector. The agenda of this chapter is to first present background of the study, history of investment in Pakistan, and the gap in the literature on the link between public and private investment at sectoral level. Next, the chapter presents the objective of the study. Finally the chapter presents the significance of the study and the structure of the thesis.

### **1.1. Background**

The debate about whether an increase in public investment, crowds in or crowds out private investment has attained much attention in the literature. The reason behind is that public investment can have a positive or negative impact on private investment. In case of positive impact, the public investment increases the private investment through the provision of infrastructure, resulting crowding in. However, in case of negative impact of public investment, the public investment competes with private investment, as a result it crowds out private investment. The term investment is used to describe the expenditures on those good which are terminated at least for a year (Turrini, 2004). Investment has two forms, individual level and national level. Productive outcomes are attained from both forms. The investment at national level has further two types. These two types include private investment and public investment (Fatima, 2012). Private

investment consists of the acquisitions of capital assets that is expected to broaden the value of assets and income. Capital asset is basically a property or good which is not easy to sell, but usually the acquisition of capital is helpful in generating profit. Buildings, land, equipment and machinery are the example of capital assets. Lloyd (1999) reports that the main objective of private investors is to maximize their profit by extending their existing capital stock. Moreover, by incorporating new technology the firm can attain higher profit than the normal profit (Schumpeter, 1934).

There are four types of public investment which include investment in infrastructure<sup>1</sup>, human capital<sup>2</sup>, research and development<sup>3</sup> and investment in general enterprises. The gross fixed capital formation is set up of fixed assets that include physical assets, intangible assets like software and the military expenses which facilitate civilian like hospitals. On the other hand, "purchase of military weapons and their supporting systems" are not the part of gross fixed capital formation.

Mostly, the public investment is one of the main factors that contribute in economic growth. Moreover, the public investment may assist and motivate private investment by the provision of infrastructure. Thus, the output will increase through the channel of increasing capital productivity and increasing the availability of resources. On the contrary, public investment has adverse effects on private investment if public expenditures lead to raise the future taxes and interest rate that would increase the cost

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<sup>1</sup> Construction of roads, buildings and railways etc.

<sup>2</sup> It is the arrangement of basic needs like health and education.

<sup>3</sup> The purchase of technological equipment and expenses on the adaption of new technology.

of financing. Further, the publicly produced goods that are substitute of private produced goods depress the private investment (Phetsavong & Ichihashi, 2012).

Government can finance its expenditures through different ways from domestic sources like financing through issuing government bonds, tax collection, and printing of new money (Bell, 2000). Government investment expenditures financed through floating of bonds diminishes the loanable reserves (funds) which are accessible for private investment (Diamond, 1965; Emran & Farazi, 2009; Hyder & Qayyum, 2001; Looney, 1995; Mitra, 2006; Shafik, 1992). If public expenditures are tax financed then higher taxes reduce the after tax returns to private investment. Moreover, it will reduce disposable income and consumption, which in turn affects private investment negatively. Public investment expenditures may adversely affect private investment by reducing availability of saving for private investment. Thus, this mode of financing may also crowd out private investment from the domestic capital market (David & Scadding, 1974; Seater, 1993).

The positive or negative relationship between public investment and private investment indicates that public investment can be either complementary or substitute to private investment. The corresponding nature of public investment which increases the private investment establishes crowding in effect. This positive effect is due to the availability of more public investment in infrastructure which in turn increases the provision of capital and hence increases the productivity of all available resources (Aschauer, 1989; Blejer & Khan, 1984; Munnell, 1992; Ramirez, 1994). The replacing nature of public investment which diminishes private investment demonstrates the crowding out effect. The replacing effect arises when government produces goods and services that are the substitutes of privately produced goods. Further, the use of additional financial and

physical resources by government that otherwise would have been available to the private investors may decrease the private investment (Phetsavong & Ichihashi, 2012).

Empirical evidence shows contradicting results. Some studies show crowding in effect of public investment on private investment. However, others show crowding out effect<sup>4</sup>.

The effect of public investment on private investment for Pakistan has been examined by many researchers. Hussain, Muhammad, Akram, and Lal (2009), Saeed, Hyder, Ali, and Ahmad (2006), Rashid (2006), Naqvi (2002), Hyder and Qayyum (2001), Looney (1995) showed that public capital formation has a crowding in effect. However, Saghir and Khan (2012) Ghani and Din (2006), Hyder and Qayyum (2001), Haque and Montiel (1993) found crowding out effect in case of Pakistan.

Saeed *et al.* (2006) examined the effects of public investment at aggregate and disaggregate level in a VAR model using data on public investment, private investment, labor force and GDP. Hussain *et al.* (2009) found that defense and debt servicing crowded out private investment while development expenditures like infrastructure, health, and education have crowded in private investment. Looney (1995) indicated that the investment in infrastructure crowd out private investment in industrial sector of Pakistan because public investment in infrastructure leads to larger deficit and domestic borrowing, which in turn, cut down the credit availability for private investment. Empirical findings of Ahmad and Qayyum (2008a) indicated that the public investment expenditure increased the private investment in agriculture sector of Pakistan, but due to instability and uncertainty, the private investment in agriculture sector has decreased.

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<sup>4</sup> For examples of the studies showing crowding in are Rashid (2006), Serven (1996), Erenburg (1993), Aschauer (1989), and Blejer and Khan (1984). Likewise, the studies that show crowding out are Gjini and Kukeli (2012), Cavallo and Daude (2011), Furceri and Sousa (2011) and Voss (2002).

## 1.2. History of Investment in Pakistan

First time in the history of Pakistan, nationalization policy was announced in 1972 by Zulfikar Ali Bhutto. The government investment dominated through increase in the investment activity as government investment was double than private investment. The private investment was discouraged due to nationalization process. In the mid of 1977 the military government of General Zia-ul-Haq took the charge. He started denationalization and deregulation. The military government started to decrease the expenditures on the public sector. To check the performance of public sector, specifically in industrial unit, a commission was established. To encourage the private investment more opportunities were provided. Despite the betterment of economy in the shape of output and exports, the financial constraints still persisted. This constraint put pressure on investment.

Although several reforms were introduced in 1978-88, but the government savings remained persistently low, with insufficient expenditure on development, incompetent of financial sector and the high level of debt. In order to control this situation, the government employed the IMF stabilization program which focused on foreign exchange liberalization and inflation control, encouraging the openness of the economy and free markets. These reforms had adverse effects on the economy of Pakistan in the 1990s. In the government of Nawaz Sharif in 1991 privatization was launched, but the growth rate of GDP was low because of inconsistent government's policies and political instability. Moreover, in the 1991-1998 government was changed four times. Other factors also had adverse effects like diseases of cotton crops and international obligations after the attainment of nuclear power in 1998. Therefore, investment was low (Sial, Hashmi, & Anwar, 2010).



In 2000 the banking sector was privatized which helped the economy in the achievement of higher growth. In 2004-06 through the services and industrial sector economy attained sustained growth of 6-8%. In 2007 the economy was growing by 7% due to manufacturing sector and industrial sector that contributed 8.4 percent and 8 percent share in GDP, respectively. In 2008 public investment and private investment declined due to political instability, security risk, energy crisis and adverse law and order situation. Moreover, the non-development expenditures of government raised fiscal deficit. Thus, public and private investment declined (Hashmi, Akram, & Hashmi, 2012). Due to all these factors Pakistan was trapped in low growth and the average income growth remained approximately 3.5% per annum over the period 2008-13.

### **1.3. Gap in the Literature**

When we look at the previous international studies we observe that most of them have focused on the effects of public investment on private investment at aggregate level. See, for example, Gjini and Kukeli (2012), Furceri and Sousa (2011), Hatano (2010) Erden and Holcombe (2006), Mitra (2006), Naqvi (2002), Voss (2002), Laopodis (2001), Erenburg (1993), Serven (1996), Bajo-Rubio and Sosvilla-Rivero (1993), and Haque and Montiel (1993). Similarly, most of studies on Pakistan such as Fatima (2012), Saghir and Khan (2012), Hussain *et al.* (2009), Rashid (2006), Naqvi (2002), and Hyder and Qayyum (2001) have also worked on aggregate level. Yet a few studies such Ahmad and Qayyum (2008a), Saeed *et al.* (2006) and Looney (1995) have used sector level data but they analyzed only one or two sectors. Therefore, there is still a

gap in the literature which needs to be filled by conducting a detailed research on the linkages of public and private investment at disaggregate level in Pakistan.

As already mentioned previous research on Pakistan examines one or two sectors. We want to explore the effects of public investment on private investment considering six sectors. The six sectors are Agriculture, Mining and Quarrying, Manufacturing, Construction, Transport Storage & Communication and Financial Institution. Following previous studies, we use output (GDP) and interest rate as control variable in our empirical analysis.

#### **1.4. Objectives of the Study**

The objectives of this study are

- To analyze the impacts of public investment on private investment in case of Pakistan.
- To examine differences in the effect of public investment on private investment across different sectors in the short run as well as in the long run.

#### **1.5. Significance of the Study**

Investment is key to economic growth. Public investment and private investment differ from each other. Private investment is on profit seeking basis, while public investment is generally for the welfare and development of the country. Moreover, public invest in long-term and in risky projects. However, private investors do not participate normally in long term and risky projects. Pakistan is a country where in previous years there has been more uncertainty and more macroeconomic instability because of political instability, lack of consistent policies and growing external debt and more recently due to war against terrorism. So it is core interest to analyze the linkage between public

investment and private investment. There can be differences in relationship of public and private investment across different sector due to different types and nature of these investments, and our short run and long run time periods.

The empirical analysis of our study stresses how public investment affects private investment in case of Pakistan. It also shows the link between public investment and private investment in same sector. Further, the effect of macroeconomic performance of the economy on private investment decision of different sectors is also evaluated. This study can be helpful to encourage the private investor for investment because in case of positive link the investors can get more profit in investing rather than getting interest on saving.

This study can assist the government in making appropriate investment policies. In particular, this study would help in identifying the sectors where public and private investments are more closely associated. It may give more accurate information if government wants to improve any specific sector through its investment decisions. This study would also beneficial in formulating future policies.

#### **1.6. Thesis Outline**

The objective of this chapter is to become aware of the thesis topic in the introduction section. Its goal is to shed light on the emphasis of the research; the link between public investment and private investment at sector level of the Pakistan's economy. We have taken six sector of the Pakistan economy which are Transport and Communication sector, Mining and Quarrying sector, Manufacturing sector, Finance sector, Construction sector and Agriculture sector. Therefore, the research objective and the gap are discussed. The rest of the thesis is organized as follows.

Chapter 2 provides theoretical background in which we discuss in detail the different theories of investment linking public investment to private investment namely; Marginal theory of investment, Accelerator theory, Flexible accelerator theory, Neo-classical theory, Keynes theory of investment, Ricardian equivalence theory, and Neoliberal theory.

In Chapter 3, we provide the comprehensive review of literature on the link between public investment and private investment. Significantly, we divide the literature review in to three sections. 1<sup>st</sup> section deal with the existing empirical evidence on positive effects of public investment on private investment at aggregate level. The 2<sup>nd</sup> section of this chapter presents the negative effects of public investment on private investment at aggregate level. The 3<sup>rd</sup> section of this chapter deal with effects of public investment on private investment at disaggregate level. Finally, we present at the end of this chapter the summary of literature view and explain how our study is different from earlier research.

In Chapter 4, we discuss the detailed explanation of the methodology, data and definition of variables used in this research. In this chapter firstly, we explain methodology and estimation techniques. Secondly we explain the data and data sources. In estimation techniques, we use the unit root test for checking the stationarity of variable, and Johansen cointegration to checking the long run relationship between public and private investment. The impulse response functions and variance decompositions are used for graphical and tabular presentation of response of private investment to various shocked in public investment. Finally, we use the vector error correction model for analyzing long run and short run relationship between public investment and private investment at aggregate as well as at sector level.

Chapter 5 presents our empirical results of six sectors as well as of aggregate level. Finally, in Chapter 6, we conclude the overall analysis and discuss the policy recommendations and directions for future research.

## **Chapter 2**

### **Theoretical Background**

The purpose of presenting theoretical background is to provide the link between investment theories with reference to public and private investment. For this, we present different theories of investment. Public and private investment linkages can be observed in multiple ways. First, a rise in public investment is greatly subsidized and due to inefficiency of public owned enterprises, private investment and growth may decrease. Second way is an increase in public investment as a part of aggregate demand can increase economic growth. Third, a rise in private investment places pressure on the government to increase infrastructure facilities (Hyder & Qayyum, 2001).

There is a lot of literature about investment behavior especially, the models that are appropriate for developing countries. The conventional models due to some limitations are not any more considered applicable for developing countries. Like accelerator model may best fit the investment behavior of industrial countries but the assumptions of perfect capital markets and no liquidity restrictions makes it less meaningful for developing countries. Some of the investment models are concisely discussed here to have an understanding in the light of existing literature.

#### **2.1 Theories of Investment and Public Private Investment Relationship**

Many theories of investment are distinct in term of their focused variables that are output, interest rate, profit, etc. Important theories which show the relationship between public and private investment are expected profit theory, marginal efficiency theory, accelerator theory, Neo-classical theory, Ricardian equivalence theory and Neoliberal approach.

### **2.1.1. Marginal Theory of Investment**

An ancient theory of investment is the marginal efficiency theory. It states that the investment should be undertaken when marginal efficiency of additional investment must be greater than the cost of financing. If cost of financing is higher than its marginal efficiency, then it has adverse effects on private investment. Thus, investment is unprofitable because interest rates are higher than the return on investment. If the interest rate is high then it would be more profitable to lend the available funds at the prevailing interest rate, rather than investing for productive purposes. In this way, it will decrease the private investment. Thus, the relationship between public and private investment can be established under marginal theory of investment. Specifically, public investment affects private investment through the interest rate channel. In particular, increases in government investment may lead to decrease in the available funds, as a result this channel pushes interest rates up. Thus, private investment decreases.

The British economist John Maynard Keynes used the same idea of marginal efficiency of investment with little amendments. However, he used the marginal efficiency of capital rather than marginal efficiency of investment. He proposed that the main determinant of private investment is profit expectation rather than the interest rate.<sup>5</sup>

### **2.1.2. Accelerator Theory**

The acceleration principle was proposed by Clark (1917). In early 20<sup>th</sup> century the accelerator theory was developed by Carver and Aftalion. The theory states that “desired level of capital stock is proportional to output”. Investment is proportionate to

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<sup>5</sup> Profit expectation means that the investor invest in those projects where he has more expectation of profit rather than focusing on interest rates.

the output growth in all periods. Government investment increases as a result the capital stock increases, with the accumulation of capital stock the private investment increases. The theory also proposed the idea that growth appeals investor which enhances the further growth via accelerator effect. Increase in GNP indicates a general rise in sales, cash flows and profits. This, in turn, tends to enhance the confidence of investor to increase investment. As a result private investment increases. The speed of growth boosts by increases in consumer income and expenditures. This is known as multiplier effect.

### **2.1.3. Flexible Accelerator Model**

The general form of accelerator model is flexible accelerator model. The flexible accelerator model was developed by Koyck (1954). This model shows the relationship between investment and output. This model is based on the idea “the greater the gap between desired capital stock and existing capital stock, higher would be the rate of investment”. The hypothesis of this model is based on investors plan to minimize the gap between actual capital stock and desired capital stock. Two channels are developed in this context. First is capital accumulation, where, output of the economy increases due to increase in the government investment. This channel leads to increase in the private investment. Second channel refers to cost of capital, when the government investment increase which leads to increase the cost of borrowing for private investors. As a result private investment and capital stock will decrease.

### **2.1.4. Neo-Classical Approach**

Jorgenson (1971) developed the Neo-Classical theory and it is a modified version of flexible accelerator model. According to this approach, the desired capital stock is



proportionate to the output and cost of capital which in turn depends on the interest rate, tax structure and price of capital goods. The key element of investment model is interest rate so it adversely affects private investment. Neo-Classical approach believes that, an increase in public investment leads to decrease the amount of funds available for private investors, competition will lead to increase the interest rate and decrease private investment. Thus, government financing pushes the interest rate up and private investment decreases. One of the main criticism on Neo-Classical theory is that the assumption of reversibility<sup>6</sup> of fixed capital.

#### **2.1.5. Keynes Theory of Investment**

First time, Keynes (1936) considered investment as independent variable. Keynes theory of investment has two aspects. First, if the expected future profit rate is larger, than the chance of investment is more because investment is feasible. Second aspect is linked with higher rate of interest which is associated with the relationship of public and private investment. Interest rate rises due to increase in public investment, which means that the cost of borrowing is high for private investors hence adversely affects private investment. However, Keynesians claim that the positive effect of an increase in public investment is greater due to multiplier effects than the negative effect in terms of reduction in private investment. Given this, the output of an economy increases with public investment. The two opinions have been made about crowding out, such as the full crowding out and partial crowding out. The full crowding out occurs only in exceptional cases when the negative effects of reduced private investment cancel out

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<sup>6</sup> Any time the Conversion of firm fixed investment into liquid.

the positive effect of increases in public investment and thus, the output of the economy remains the same.

#### **2.1.6. Ricardian Equivalence Theory**

Ricardian Equivalence theory was developed in 19<sup>th</sup> century by David Ricardo. The main idea behind this theory is, that government tries to boost the demand by increasing government expenditures through debt financing, but the demand remain the same. Because the people are willing to save their excessive money in order to pay the increase in future taxes to pay off the debt. Ricardian equivalence theory is contradictory to Keynes theory of investment. The major criticism on Ricardian equivalence is their unrealistic assumptions<sup>7</sup>. Ricardo gives justification of the crowding out effect. As stated by him, government expenditure need to be financed, at present or in future through taxes. In future the taxes will be high that will lead to decrease in disposable income. Thus, with the decrease of disposable income people will have less money to invest. This will adversely affect private investment (Xu & Yan, 2014).

#### **2.1.7. Neoliberal Approach**

The latest approach which describes the importance of financial expansion and the rate of interest in the progress of economic development is called Neoliberal approach. The advocates of this approach McKinnon (1973) and Shaw (1973) reported that the real interest rate and investment might have a positive relationship because a higher real interest leads to increase savings. When saving is high the availability of funds for

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<sup>7</sup> "The assumption of (a) Existence of perfect capital markets. (b)The individual have ability to borrow and save at any time. (c)The individual are willing to save for increase in unseen future taxes."

private investment is high. This is known as MacKinnon and Shaw's hypothesis. This hypothesis is established on the assumption of limitations in the quantity of financial resources instead of cost of financing. In the context of developing countries public investment plays an important role in economic growth.

Neoliberal approach has established a positive relation between the real rate of interest and investment. On the other hand, this is contradictory with Neo-classical frame work. Higher real rate of interest may decrease the investment but implicit (realized) investments increase due to increase in the availability of funds. This phenomenon is known as "Conduit effect".

In sum, marginal theory of investment and Neo-classical theory established the negative relationship between public investment and private investment due to less availability of loanable funds. The availability of funds are limited. Moreover, the flexible accelerator theory and Keynes theory also suggested the negative relationship between public and private investment due to cost of borrowings. However, the accelerator and flexible accelerator theories suggested positive relationship between public and private investment due to accumulation of capital stock. Neoliberal approach is contradictory with the Neo-classical theory of investment because Neoliberal approach explained the positive relation between increase in interest rate and investment through saving channel. But the Neo-classical approach supports the crowding out effect. On the basis of this theoretical background based on different models we can say that the exact nature positive or negative (complementary or substitute) of relationship between public and private investment is inconclusive.

## Chapter 3

### Review of Literature

The review of empirically literature is divided into three section. First section reviews studies which are in favor of crowding in effects of public investment on private investment at aggregate level of the economy. Second section includes those studies which are in favor of crowding out effects of private investment on private investment at aggregate level. Third section deals with those studies that analyze the effect of public investment on private investment at sector level.

#### **3.1. Crowding in Effects of Public Investment on Private Investment at Aggregate Level**

The investment in infrastructure by public sector was analyzed by many researcher like Aschauer (1989), Blejer and Khan (1984) and Buiter (1977). Buiter (1977) found that complementary relation existed between public investment and private investment, considering the public investment in projects such as dam construction. He separately identified that the portion of government spending that represented purchase of public capital affected the productivity of private capital. This possibility changed the responsiveness of the normal neutrality implication<sup>8</sup> because the public spending that characterized as public capital led to real effects on private investment and output.

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<sup>8</sup> Neutrality implication considered that when agent presumes a raise in demand produce by an anticipated increase in government expenditure, wages will increase, likely aggregate price rise as a result aggregate supply shifting to left. This aggregate supply response offset any expansionary effect on real output.

Blejer and Khan (1984) focused on the public infrastructure investment. Their analysis consisted of 24 developing countries using annual data from 1971-79. From restricted least squared method they concluded that public infrastructure investment crowded in private investment and public non infrastructure investment crowded out private investment. Moreover, credit availability also appeared as an important element in the determination of private investment.

With the help of regression analysis based on the data from 1925 to 1985 Aschauer (1989) found that public investment in infrastructure had a positive effect on private investment in the US economy. He showed that crowding in effect occurred over the time in long run as well as in the short run. In the long run change in public investment by one percent led to an increase of 9 percent in private investment. Moreover, in the short run public investment raised the private investment but the increase in private investment was just 50 percent of long run increase. Private investment needs public infrastructure such as roads, railway tracks electricity facilities, etc. That's why in the short run it also has positive effect but smaller in magnitude. However, in the long run private capital is necessary for production as well as for the distribution of goods and services. Thus, the return on private capital increased, as a result it attracted more private capital.

Erenburg (1993) also found that public capital boosted up private investment in equipment and machinery which seemed important for economic growth and showed a significant positive correlation with GDP growth rate. He derived his results with the help of full-informed likelihood statistics (FIMS) obtained for us economy over the period 1947-85.

Serven (1996) found that long run public infrastructure investment crowded in private capital, using data of India from 1961-1981. He found that public investment in infrastructure took two years to materialize. Therefore, in short term public investment crowded out private capital because public investment used the same resources which otherwise were available to private sector.

The impact of public investment on private investment has been empirically analyzed by Erden and Holcombe (2006), Naqvi (2002), Hyder and Qayyum (2001), and Ghura and Goodwin (2000) investigated the determinants of investment in cross national data taken from Asia, Sub-Saharan Africa and Latin America. In the sample of 31 developing countries pooled data from 1975 to 1992, private investment is motivated by increases in public investment, improvements in financial intermediation, decrease in credit for public sector and decrease in interest rate. Moreover, Naqvi (2002) and Hyder and Qayyum (2001) analyzed the linkage between public and private investment of Pakistan. Naqvi (2002) used vector autoregressive (VAR) technique on annual data from 1964-2000 through VAR. The capital formation of public sector showed significant positive impact on private investment. Hyder and Qayyum (2001) tested the crowding out hypothesis by using annual data from 1964-2001 through error correction model (ECM). The results confirmed the positive relation between public and private investment.

Erden and Holcombe (2006) investigated the panel data of 19 developing countries from 1980 to 1997 by using pooled OLS, fixed effect and error correction model (ECM). They concluded that public investment is complementary to private investment. In the long run an increase of one percent in public investment increased the private investment by 0.54 percent. The short run analysis also showed crowding in effect. Further, the main factor which affected the private investment was credit availability

because with less developed financial institutions, the availability of credit appeared constraining factor on private investment in developing economies but interest rate did not show significant effect on private investment. This study was based on flexible accelerator model. Moreover, their study provided the comparison between developed and developing countries by running the same empirical models on the panel of developed countries. They concluded that in developing countries public investment has positive impact. However, in developed countries it showed adverse impact.

Rashid (2006) examined the relationship between public and private investment in Pakistan by using annual data from 1965 to 2005. Johansen cointegration approach, impulse response function and variance decompositions were utilized to check the relationship between public investment and private investment. The estimates of impulse response function (IRF) showed that response to shock is positive and significant. However, the estimates of variance decomposition gave the weak indication about the role of public investment shocks in explaining the response of private investment. The empirical results showed the existence of positive relationship on the basis of error correction model (ECM).

Al-Abdulrazag (2010) and Ang (2009) explored the relationship between public investment and private investment by vector error correction model. Ang (2009) analyzed private domestic investment and foreign direct investment for Malaysia from 1960-2003. This study suggested that public investment was linked with private investment which led to increase private investment. Al-Abdulrazag (2010) analyzed time series of Jordan from 1976-2004. The result suggested a positive relation between public and private investment.

Laopodis (2001) examined the effects of public spending on military and non-military expenditures on private investment. The non-military expenditure had further three sub categories consisting of infrastructure, consumption and general government expenditure. He analyzed the economy of Greece, Portugal, Spain and Ireland through error correction model (ECM). The data used in this analysis was from 1960 to 1997, but the Ireland's data were from 1970 to 1997. He found that in countries like Greece, Portugal, Ireland that faces low level of real development, the high non-military public spending have a positive effect on private investment because these two magnitudes augment to one another at the initial stages of development. However, in the case of more developed country like Spain government spending discouraged the private investment because public capital is considered as the substitute of private capital.

Hatano (2010) examined the reasons for inconsistent results regarding crowd in. Therefore, he analyzed the long run relationship between public investment and private investment on the stock<sup>9</sup> phase instead of flow<sup>10</sup> phase. He estimated the error correction model (ECM) for Japanese data for the period from 1955-2004. He concluded a complementary relationship between public investment and private investment.

Gjini and Kukeli (2012) examined the public and private investment linkages for 11 Eastern Economies comprising of 6 developing and 5 developed economies. The study was based on panel regression analysis. These countries showed differences in many aspects that's why the weighted least square (WLS) econometric model was used. The analysis confirmed a positive linkage between public investment and private

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<sup>9</sup> Stock variable is the one which don't have any time restriction. In fact it is a quantity which is measured at a certain time.

<sup>10</sup> Flow variable is the one which is assigned with a time component. It is a quantity which is measured at some time period.



investment. The marginal effect of public investment on private investment was positive and started to decrease when economy moved from developing to more developed economy.

### **3.2. Crowding out Effects of Public Investment on Private Investment at Aggregate Level**

There has been many researchers who found crowding out effect of public investment on private investment. There are many factors which are contributing to discourage private investment. Credit availability is an important factor that influences the level of private investment and a number of studies supported it e.g., Cavallo and Daude (2011), Erden and Holcombe (2005), Ghura and Goodwin (2000), Ramirez (1994), Aschauer (1989) Wai and Wong (1982). The limited financial resources for private investment appeared more relevant to developing countries. Increasing the availability of credit has positive effect on private investment.

Ramirez (1994) examined the Mexican economy by using data from 1950-88. He used modified accelerator model. He concluded that in eighties due to implementation of deflationary policies public investment crowded out private investment. In this study the Engle Granger (EG) cointegration test was used. To determine the direction of correlation between public and private investment Granger causality tests were applied.

Voss (2002) investigated the effect of government spending on private investment for Canada and the USA by using quarterly data through VAR model. The data for US comprised of 1947Q1-1988Q1 and for Canada 1947Q1-1996Q4. In both countries he found a negative effect of public investment on private investment. In fact innovation to public investment trended to crowd out private investment. Moreover, he re-examined the Aschauer (1989) research and found the opposite conclusion.

Kustepeli (2005) investigated the crowding out hypothesis in the context of effectiveness of fiscal policy for turkey from 1967-2003. He used ADF and Johansen cointegration analysis. His results were in line with the theory that real interest rate and private investment exhibited inverse relationship, income and private investment showed positive relationship. In the long run crowding in of private investment was observed due to rise in government spending while, crowding out of the private investment was observed when government deficit increased. At overall level crowding out over weighted crowding in effect.

Ghani and Din (2006) analyzed the link between public and private investment and their impact on growth of Pakistan by using data from 1973-2004. Their results showed that public investment crowded out private investment and this result was opposite to the most popular view of crowding in. However, as Aschauer (1989) has pointed out that this relationship may be opposite if public investment leads to an intertemporal reallocation of resources from private to public sector which reduces private investment.

The effect of military and non-military public expenditure on private investment has been examined by Hussain *et al.* (2009) and Laopodis (2001). Hussain *et al.* (2009) used data from 1975-2008 by using Johansen cointegration for Pakistan and found that defense expenditure and debt servicing crowded out private investment while development expenditures crowd in private investment.

Mitra (2006) investigated the relationship between public and private investment in Indian economy by using data from 1969-2005. He used augmented Dickey-Fuller to test for stationarity and Structural Vector Auto-regressive model (SVAR). SVAR was used because reduced form VAR did not allow interactions between the impacts of rise

in government investment, on private investment and gross domestic product (GDP). He just wanted to estimate the short run relationship among government investment, private investment and gross domestic product. He found that public investment crowded out private investment.

Furceri and Sousa (2011) analyzed panel data of 145 countries from 1960-2007. Their findings suggested that government spending negatively affected both private investment and private consumption. The effect of government spending on consumption and investment seemed depend on different factors like democracy, corruption, political stability, income and interest rate. In this study they used OLS, Fixed effect and Random effect estimators. The results were robust in econometric specification. To correct the endogeneity problem their analysis further used GMM estimation proposed by Blundell and Bond (1998).

Cavallo and Daude (2011) examined the relationship between public investment and private investment using data of 116 countries from 1980-2006 by using GMM estimator. The findings showed that on average public investment crowded out private investment.

Saghir and Khan (2012) used time series data from 1970-71 to 2009-10 of Pakistan economy by using cointegration and error correction model (ECM). They concluded that government investment negatively affects private investment. The study recommended that government expenditures should be used efficiently and in a productive way, which in turn will lead to raise the cost-effectiveness of private investment. In this way it will attract the private investors. Private investment showed more favorable effect on growth than public investment because private investment appeared more efficient.

### **3.3. Effects of Public Investment on Private Investment at Disaggregate Level**

In this part, we review those studies which explain the effect of public investment on private investment at sector level. Looney (1995) analyzed the investment in manufacturing industry. The result of Modified Granger Causality tests suggested that the investment in infrastructure crowded out private investment in industry because the public investment in infrastructure led to larger deficit and domestic borrowings shorten the credit availability for the private investment.

Rossiter (2002) investigated the effects of public investment on private investment in two sectors (equipment and structure) for United States. He used cointegration approach for his analysis. He found that public investment in structure had weak positive effects on private structure. However, the public investment in equipment sector has crowding out effects.

The effect of public investment on private investment at aggregate level as well as disaggregate level was examined by Pereira (2001) and Saeed *et al.* (2006). Specifically, Pereira (2001) estimated VAR model with the variables like private gross domestic product, private investment, public investment and private employment for US economy and public and private investment were further disaggregated into high ways, education, electric and gas facilities, sewage, water supply, hospital building and development structure. At aggregate level he found that public investment had crowded in effect on private investment. At disaggregate level the crowding in effect was strong on industrial equipment and transportation equipment.

Saeed *et al.* (2006) examined the effect of public investment at aggregate as well as disaggregate level by using real variables like public investment, employed labor force,

GDP and private investment. They found that agriculture sector show crowding in effect while manufacturing sector showed crowding out effect.

Ahmad and Qayyum (2008b) investigated the effect of public spending and macro-economic uncertainty on fixed private investment in services sector<sup>11</sup> of Pakistan from 1972-2005 by using error correction model (ECM). This study first tried to include the influence of uncertainty and non-development government spending on private fixed investment in services sector of Pakistan. The non-development government spending seemed as a substitute to private investment. Hence, in long run private investment was crowded out in services sector.

Hassan, Othman, and Karim (2011) supported the crowding in effect of public investment on private investment by using data from 1976-2006 on four sectors (Agriculture, Construction, Transport & Communication, industry and Trade) of Malaysian economy by using fully modified ordinary least square (FMOLS), first proposed by Phillips and Hansen (1990). They found that public investment had significant positive effect on private investment in three sectors excluding agriculture sector, because private sector responds to government policies that are more focused on manufacturing sector rather than agriculture sector. Therefore, private investment decreased in agriculture sector.

Kollamparambil and Nicolaou (2011) analyzed South African economy by using quarterly data from 1960 to 2005 at sector level. They found that the relationship between public and private investment and GDP. The effect of public investment on GDP was direct but the effect of public investment on private investment was indirect.

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<sup>11</sup> Services sector comprises of transport, whole sale and retail trade, storage and communication, finance and insurance, ownership of dwelling public administration and defence, social community and personal services.

Hence, public investment decreased mainly in transport equipment and machinery sectors till 2005. However, in the other sector like construction sector public investment increased till mid of 1990. Private investment increased through the accelerator effect because the demand of privately produced good increased due to decline in public investment. Moreover, they suggested that private investment should increase through the provision of infrastructure and well organized socio-economic environment.

Fujii, Hiraga, and Kozuka (2013) examined the effect of public investment on private investment at sector level by using data from 1983-2008 through Factor Augmented VAR model (FAVM). This model is capable for analyzing the extent to which the public investment crowds out or crowds in industrial investment. He found that the effects on sectoral capital investment varied from industry to industry because of different policy implications. Some sectors showed negative effect of public investment on private investment due to misallocation of resources but on the whole, crowding in effect dominated.

Xu and Yan (2014) classified the government investment in to two types. First type consisting of investment that assisted to provide public goods and infrastructure and second dealt with public investment in private industry and commerce. The effect of these investment on private investment in China was analyzed from 1980-2011 by Structural Vector Auto Regresses (SVAR). The results proposed that investment of government in the provision of public goods crowd in private investment. The proposed that China's government should increase the investment that facilitates the private investment and should reduce the investment in those sectors which directly compete with the private sector.

This chapter documented the review of prior studies about the relationship of public investment on private investment. Evidence from prior studies give mixed results with possible reason for the result may be due to difference in the structure of economies. We examine in our study the effects of public investment on private investment in six sectors for Pakistan economy and also at aggregate level. There has been no prior study that has comprehensively considered these six sectors and used cointegration and ECM for observing differences in short and long run relationship.

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**Table 3.1: Summary of Literature Review**

<b>Authors</b>	<b>Year</b>	<b>Data sample</b>	<b>Methodology</b>	<b>Country</b>	<b>Conclusion</b>
<b>Blejer and Khan</b>	1984	1971-79	OLS	24 developing countries	Crowding in
<b>Aschauer</b>	1989	1925-85	Multivariate Cointegration	USA	Crowding in
<b>Erenburg</b>	1993	1947-85	FIMS	USA	Crowding in
<b>Ramirez</b>	1994	1950-88	Engle Granger Causality	Mexican economy	Crowding out
<b>Looney</b>	1995	1985-93	Granger Causality	Pakistan	Crowding out
<b>Serven</b>	1996	1961-81	OLS	India	Crowding in
<b>Ghura and Goodwin</b>	2000	1975-92	Random effect	31 developing countries	Crowding in



<b>Naqvi</b>	2000	1964-2000	VAR	Pakistan	Crowding in
<b>Pereira</b>	2001		VAR	US	Crowding in
<b>Hyder</b>	2001	1964-2001	ECM	Pakistan	Crowding out
<b>Voss</b>	2002	1947-66	VAR	Canada USA	Crowding out
<b>Kustepeli</b>	2005	1967-2003	ADF, Johansen Cointegration	Turkey	Crowding out
<b>Rashid</b>	2006	1965-2005	Johansen, IRF, VDC, ECM	Pakistan	Crowding in
<b>Ghani and Din</b>	2006	1973-2004	VAR	Pakistan	Crowding out
<b>Mitra</b>	2006	1965-2005	SVAR	India	Crowding out
<b>Saeed et al.</b>	2007	1973-2006	VAR	Pakistan	Crowding in

<b>Erden and Holcombe</b>	2006	1980-97	OLS, Fixed effect, ECM	Pakistan	Crowding in
<b>Ahmed</b>	2008	1972-2005	ECM	Pakistan	Crowding out
<b>Hussain <i>et al.</i></b>	2009	1975-2008	Johansen Cointegration	Pakistan	Crowding in
<b>Ang</b>	2009	1960-2003	VECM	Malaysia	Crowding in
<b>Furceri and Sousa</b>	2009	1960-2007	OLS, Fixed effect, Random effect, GMM	145 countries	Crowding out
<b>Al-Abdulrazag</b>	2010	1976-2004	VECM	Jordan	Crowding in
<b>Laopodis</b>	2010	1960-70	ECM	Greece, Spain, Portugal and Ireland	Crowding in
<b>Hatano</b>	2010	1955-2004	ECM	Japan	Crowding in
<b>Cavallo and Daude</b>	2011	1980-2006	GMM	116 countries	Crowding out

<b>Hassan <i>et al.</i></b>	2011	1976-2006	FMOLS	Malaysia	Mix results some sector show crowding in and some show crowding out
<b>Kollamparambil and Nicolau</b>	2011	1960-2005	VAR	South African economy	Crowding in
<b>Gjini and Kukeli</b>	2012	1991-2009	WLS	11 eastern countries	Crowding in
<b>Saghir and Khan</b>	2012	1970-2010	ECM	Pakistan	Crowding out
<b>Fuji <i>et al.</i></b>	2013	1983-2008	FAVM	Japan	Crowding in
<b>Xu and Yan</b>	2014	1980-2011	SVAR	China	Crowding in

## Chapter 4

### Empirical Framework

#### 4.1. Introduction

In this chapter, we discuss the empirical framework. This study investigates the long-run and short run effect of public investment on private investment in Pakistan at aggregate level as well as at sectoral level using annual data for the period 1971-2013. The augmented Dickey Fuller (ADF) test is used to check the stationarity of the variables. Johansen cointegration, impulse response functions (IRF), variance decompositions (VDC), and the vector error correction model (VECM) have been used to provide empirical analysis.

#### 4.2. Unit Root Test

Augmented Dickey-Fuller test for unit root is proposed by Dickey and Fuller (1979). The unit root test provides the information about the stationarity of the time series variables i.e., public investment, private investment, interest rate, gross domestic product (GDP). If the time series variable is not stationary then the series contains unit root. The presence of unit root generates unreliable results regarding the hypothesis testing. Before carrying out hypotheses testing, the non-stationary data will be differenced until stationary is attained. One way of testing for the presence of unit root and to determine the order of integration is to use the augmented Dickey Fuller (ADF) unit root test. The ADF unit root test has three forms as following

- (i) Unit root test [Random Walk (RW)]

$$\Delta y_t = \delta Y_{t-1} + \sum_{i=1}^{p-1} \alpha_i \Delta Y_{t-i} + \varepsilon_t$$

- (ii) Unit root test with a constant (RW +Drift)

$$\Delta y_t = \beta_1 + \delta Y_{t-1} + \sum_{i=1}^{p-1} \alpha_i \Delta Y_{t-i} + \varepsilon_t$$

- (iii) Unit root test with a constant and deterministic trend (RW +Drift + Trend)

$$\Delta y_t = \beta_1 + \beta_2 t + \delta Y_{t-1} + \sum_{i=1}^{p-1} \alpha_i \Delta Y_{t-i} + \varepsilon_t$$

Where  $\delta$  the coefficient of lag dependent variable,  $\beta_1$  is constant term,  $\varepsilon_t$  is the error term, and  $Y_t$  is the variable of interest. The symbol  $\Delta$  is the differencing operator,  $t$  denotes the time period.  $P$  is the number of lagged terms which are selected by Schwarz Criterion (SC).

The augmented Dickey Fuller (ADF) give solutions depending upon the above type which we use for our data analysis. Regarding selection of type, the third type which includes constant and the deterministic trend. The 1<sup>st</sup> two types consider the special case for third type and if we include irrelevant variables in regression equation than the power of test for rejection of null hypothesis (series contained unit root) will reduced. A graphical test proposed by Verbeek (2008) that help us to select the version of ADF test, if the series has upward or down word movement than it is apt to select time trend term for ADF. The optimal lag selection is minimum value of Schwartz Criteria. Thus, the rationale of selecting SC among other criteria is that it will normally select few lags with the correct model.

### 4.3. Johansen Cointegration Test

Johansen (1988) proposed the methodology for testing co-integration among the variables. The variables which are non-stationary in level form and stationary at first difference are said to be co-integrated if the residuals from their linear relationship are integrated of zero order. Then there will be a long-run relationship among the variables. In this study all variables are integrated of order (1). There are two tests in Johansen cointegration namely: Trace test and Maximum Eigenvalue test.

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^n \ln(1 - \lambda_{r+1})$$

$$\lambda_{max}(r, r+1) = -T \ln(1 - \lambda_{r+1})$$

In Trace statistics the null hypothesis is that there is no cointegrating equation and the alternative hypothesis is that there is one cointegration equation. Same interpretation of hypothesis is for Maximum Eigenvalue test. Mostly both have same results but sometimes the numbers of cointegrating equation differ in both tests. In such case Trace statistics is preferred than Maximum Eigenvalue test. The justification of using Johansen cointegration is that it is better than two steps Engle Granger because it allows testing of cointegration for more than one series which are integrated of order (1). Moreover, it analyzes the long run relationship among the variables and long run estimates of variables.

### 4.4. Variance Decompositions

The forecast error variance decomposition tells us the proportion of the movement in a sequence due to its own shock versus shocks to other variables (Enders, 2008). Variance decompositions are used to see the effect of one standard deviation shock of public investment on forecast error variance of private investment. Variance

decomposition coefficients show the significance of variables but its fail to tell the direction of the variable's response due to certain shocks. For this reason we cannot predict that the public investment crowds in or crowds out private investment from Variance Decomposition coefficient.

#### **4.5. Impulse Response Function**

Impulse response function (IRF) refer to the reaction of any dynamic system in response to some external changes. Impulse response function is used to analyze the dynamic interactions between variables and impact of various shock on variables. Order of variables are important. Thus, follow the Cholesky ordering for meaningful results and interpretations proposed by Orden and Fisher (1993). In impulse response functions the graphical presentation of response of private investment at aggregate and sector level to one standard deviation shock in public investment is presented.

#### **4.6. Vector Error Correction**

The existing literature shows that the effect of public investment on private investment through different approaches like vector auto regression (VAR), auto regressive distributed lag (ARDL), weighted least square (WLS), factor augmented vector auto regression (FAVAR), ordinary least square (OLS), fixed effect, random effect, generalized method of moment (GMM), full information maximum likelihood (FIML), fully modified ordinary least square (FMOLS), and vector error correction models (VECM).

A Vector Error-Correction Model helps to examine the presence of equilibrium or disequilibrium between short-run dynamics and long-run equilibrium. Further, the estimate of error correction term explains the extent of disequilibrium that can be

eliminated at each period. In other words, on the basis of the size of the error correction term, we come to know that the responsiveness of the changes in private investment due to the previous deviation of actual values of private investment from the long-run equilibrium values. How quickly disequilibrium can be corrected depends on the size of the estimate of error correction term. If the size is larger than the proportion of error correction will be larger. Therefore the co-efficient of the error term can be interpreted as the estimates of the speed of adjustment between short-run dynamics and long-run equilibrium values. The same methodology is applied to different sectors; to study the long-run relationship between public investment and private investment. We take six different sectors as well as take the aggregate level of investment.

#### 4.7. Specification of Econometric Model

Pesaran and Smith (1998) suggested Vector Error Correction Model to explore the relationship between public investment and private investment.

$$\Delta y_t = \sum_{i=1}^{p-1} \Gamma_{iy} \Delta z_{t-i} + \Pi_y \Delta z_{t-1} + \lambda_y \psi_t + \alpha_{1y} t + \alpha_{0y} + \xi_t \quad t = 1, 2, 3, \dots, T \quad (1)$$

$$\Delta x_t = \alpha_{0x} \sum_{i=1}^{p-1} \Gamma_{ix} \Delta x_{t-i} + \zeta_t \quad (2)$$

$y_t$  = vector (2×1) of endogenous variable at I(1) that is fixed public investment and fixed private investment.

$x_t$  = vector of (2×1) exogenous variable at I(1) that is real interest rate and GDP.

$$z_t = (y', x')$$



$\psi_t$  = vector of exogenous variable at I(0) which is not included in the intercept and trend

$t$  = time trend

$\Delta$  = difference operator

$\alpha_{0y}$  = represent coefficient

$\xi_t$  and  $\zeta_t$  =disturbance terms

The assumption of this model is that a response from  $\Delta y_t$  to  $\Delta x_t$ , but no response in level. Therefore,  $x_t$  is given in equation (2). Two variables are taken as endogenous i.e fixed public investment and fixed private investment variable and two are considered as exogenous including real interest rate and output.

#### 4.8. Data and Data Sources

To estimate the effect of public investment on private investment at sectoral level, this study uses 43 years annual data from 1971 to 2013 for six sectors because the data for this time span is available for only six sectors. Data on fixed public investment, fixed private investment at current prices and gross domestic product (GDP) are collected from various issues of Economic Survey of Pakistan by Finance Division of *Government of Pakistan*. Data on the real interest rate is collected from *International Financial Statistics* (IFS) published by international Monetary Fund (IMF).

**Table 4.1: Definition of Variables**

<b>Variable</b>	<b>Description</b>
GDP	GDP is an exogenous variable which shows the market value of all final goods and services that produced in a country within year. We used nominal GDP of Pakistan as an exogenous variable.
Real interest rate	We use call money rate (interest rate) as an exogenous variable in our estimation process. We obtain Real interest rate by deducting inflation rate from nominal interest rate.
Fixed Public Investment	We take gross fixed public capital formation at current market prices as an endogenous variable in our estimation process at both aggregate level, as well as at sectoral level.
Fixed private investment	We take gross fixed private capital formation at current market prices as an endogenous variable in our estimation process at both aggregate level, as well as at sectoral level.

# Chapter 5

## Empirical Results

### 5.1. Introduction

The previous chapter describes the empirical framework, estimation technique, and data. In this chapter, we present the empirical results and their analysis. To overview the data, first we present the summary statistics. The summary statistics consists of mean, standard deviation, minimum and maximum values of each variable. After this we check the unit root and apply Johansen cointegration to check the existence of long run relationship among variables. Then we use variance decomposition and impulse response function for tabulated and graphical analysis of shocks, respectively for all sectors. Finally, Vector Error Correction Model (VECM) is applied to check the long run as well as short run relationship among public and private investment in different sectors.

### 5.2. Descriptive Statistics

We present descriptive statistics of all variables that are used in this study in Table 5.1. The purpose of descriptive statistics is to check the nature of all variables. Data for all sectors except agriculture sector data spans from 1971 to 2013. However, agriculture sector data is used from 1981 due to non-availability of data from public sources. Therefore, we have only 33 observations for agriculture sector. Mean basically reflects the average value of variables while standard deviation measures the deviation of variable from their mean value. The mean of interest rate is 8.67 and the corresponding figure for output is 7.05.

**Table 5.1: Summary Statistics**

Variables	Observation	Mean	Standard Deviation	Min	Max
Interest rate	43	8.675	2.392	2.140	12.470
Output	43	7.056	1.763	3.921	10.020
Public Investment Overall	43	10.725	1.217	7.756	12.412
<b>Public Investment Sector-wise</b>					
Transport and Communication	43	9.385	1.814	5.568	12.668
Mining and Quarrying	43	7.617	2.356	2.397	11.207
Manufacturing	43	8.837	1.987	4.595	12.778
Finance	43	6.765	1.901	2.302	13.140
Construction	43	8.092	0.971	6.329	10.717
Agriculture	33	9.896	2.376	6.703	13.501
Private investment Overall	43	11.387	1.986	8.169	14.635
<b>Private investment Sector-wise</b>					
Transport and Communication	43	9.322	1.980	6.408	12.828
Mining and Quarrying	43	6.715	2.921	2.890	11.462
Manufacturing	43	10.219	1.922	6.926	12.824
Finance	43	6.694	3.188	1.791	13.131
Construction	43	7.381	2.308	3.178	10.317
Agriculture	33	10.410	1.378	8.447	13.500

Note: All variables are taken in log form except interest rate.

From descriptive analysis, we can compare public investment and private investment at aggregate level and among different sectors. At aggregate level, mean value of private investment is relatively higher than public investment. Among sectors the highest mean values of public and private investment are observed for agriculture sector because this is an important sector of Pakistan. The cultivated land is one-fourth of total

area of Pakistan, and 41 percent of labor force is employed in this sector with contribution in total GDP of 21 percent. However, the lowest mean values of public and private investment are realized for financial sector. This is also an important sector but from 1974 to 1991 the insufficient reforms led to a decline in the development of financial sector. From 1991 onwards, the privatization of the financial institutions encouraged the development of financial sector. Thus, the lower mean value is observed in this sector. Among other sectors transport and communication and manufacturing sector also indicate high average value.

Standard deviation explains the volatility of variables. At aggregate level the volatility of private investment is higher than public investment. Descriptive analysis further shows that at sectoral level, in case of private investment the highest volatility is shown for financial sector, which is 3.188, while the lowest volatility is observed for the agriculture sector, which is 1.378. In case of public investment the highest volatility is observed in agriculture sector, with a value of 2.376 and lowest in case of construction sector, with a value of 0.97. The construction sector is an un-organized and most neglected sector in Pakistan. According to economic survey 2010-11 the construction industry showed the lowest growth because of non-positive policies by government, such as imposition of heavy taxes and non-availability of financial services by the financial institution. This comparison shows that agriculture sector faces least volatile private investment and most volatile public investment over the available sample of 33 years.

### **5.3. Unit Root Analysis**

The unit root test is used to check the stationarity of variables in time series data. Table 5.2 describes the unit root analysis of variables that are used in this study i.e.

**Table 5.2: Unit Root Analysis**

Variable	Symbol	Level		1 <sup>st</sup> Difference	
		ADF(i)	ADF(i+t)	ADF(i)	ADF(i+t)
Interest rate	<i>I</i>	-2.529	-2.479	-5.900***	-5.848***
Output	lgdp	-1.081	-2.665	-5.462***	-5.649***
Public investment Overall	lpb	-2.721	-2.986	-5.582***	-6.077***
<b>Sector-Wise</b>					
Transport and communication	lpbtc	-1.139	-3.160	-6.682***	-6.611***
Mining and quarrying	lpbmq	-1.721	-4.173	-8.834***	-8.762***
Manufacturing	lpbm	-1.851	-2.490	-6.448***	-6.369***
Finance	lpbf	-0.670	-3.549	-8.290***	-8.131***
Construction	lpbc	-0.369	-1.295	-6.813***	-6.941***
Agriculture	lpba	-0.420	-2.514	-5.445***	-5.381***
Private investment Overall	lpv	-0.164	-3.176	-6.166***	-6.085***
<b>Sector-wise</b>					
Transport and communication	lptc	-0.276	-2.887	-4.958***	-4.922***
Mining and quarrying	lpmq	-0.208	-2.096	-6.895***	-6.810***
Manufacturing	lpm	-1.242	-0.929	-5.464***	-5.715***
Finance	Lpf	-0.003	-4.548	-7.566***	-7.482***
Construction	Lpc	-1.242	-1.875	-7.591***	-7.752***
Agriculture	Lpa	0.994	-1.580	-6.048***	-6.337***

Note: \*\*\*denote significance at 1 percent, \*\*denote significance at 5 percent.

Public investment, private investment, output and interest rate. The stationarity of investment variables is checked for investment at aggregate level and for six sector of the economy.

In Table 5.2, “i” indicates intercept and “i+t”, indicates intercept and trend. Unit root analysis shows that at level all variables are non-stationary but at first difference the concerned variables become stationary which shows that the original data has unit root. Variables used in this study are integrated of the same order one i.e., I(1). These results are consistent with the studies of Oriavwote and Oyovwi (2014), Khan and Saeed (2012), Bose and Haque (2005), Kustepeli (2005), Rossiter (2002), Monadjemi and Huh (1998). All variables have same order of cointegration i.e. I(1). So, we proceed further with this information to Johansen cointegration to check the long run relationship between public and private investment at aggregate as well as sectoral level. We use the Schwartz criteria for optimal lag selection in Table 5.3.

**Table 5.3: Lags Selection for Cointegration (through Schwarz Criteria)**

	0	1	2	3	4
<b>Aggregate level</b>	4.303	-1.440*	-1.341	-1.089	-0.760
<b>Transport and Communication</b>	6.170	1.277*	1.545	1.699	1.829
<b>Mining and Quarrying</b>	4.191	3.189*	3.501	3.673	3.873
<b>Manufacturing</b>	3.767	2.451*	2.489	2.537	2.520
<b>Finance</b>	4.490	3.736*	3.826	3.992	4.295
<b>Construction</b>	3.767	2.451*	2.489	2.537	2.520
<b>Agriculture</b>	2.915	2.494*	2.837	3.187	3.437

Note: At aggregate level and sectoral level the optimal lag length is 1.

The selection of optimal lag length for estimation of VAR model is prerequisite for applying Johansen cointegration. The VAR model is estimate for 1 to 4 lags for annual data. The results of Schwarz criteria support one lag for cointegration models and this result is consistent with Rossiter (2002).

#### 5.4. Results of Johansen Cointegration Test

This section is further divided into sub-sections. First section deals with public private investment linkages through multivariate cointegration analysis at aggregate level. The remaining sections deal with same analysis at sectoral level. Table 5.4 reports the results of Johansen cointegration of public and private investment at aggregate level. The trace test finds the number of long run relationships or cointegration vectors. The null hypothesis of trace statistics states that there is no cointegration equation. We reject the null hypothesis at 5 percent level of significance and conclude that there is cointegration between variables.

**Table 5.4: Johansen Cointegration Statistics for Aggregate Level**

Hypothesis		Eigen value	Trace Statistics	0.05 Critical Value	Prob.***
$H_0$	$H_A$				
$r = 0$	$r > 0$	0.247	18.607	15.494	0.016
$r \geq 1$	$r > 1$	0.165	7.249	3.841	0.007

By summing up, there are two cointegrating equations for public and private investment at aggregate level. Mostly the Trace statistics and Maximum Eigen statistics give same result but in some case it can differ. Trace statistics is preferred due to giving more accurate result as compared to Maximum Eigen statistics (Asari *et al.*, 2011; Rashid, 2006).

We are using one cointegration equation despite of two cointegrating, because the highest eigenvalue is associated with first cointegration equation and it is also related to the stationarity of the variables (Oriavwote & Oyovwi, 2014; Rashid, 2009).



Table 5.5 presents the estimated coefficient of public investment is 0.528 which is positive that shows that the public investment is complementary to private investment at aggregate level. Moreover, as public investment increases by 1 percent it leads to increase the private investment by 0.528 percent.

**Table 5.5: Normalised Cointegration Coefficient at Aggregate Level**

Private Investment	Public investment
1.000	0.528 (0.178)

Note: Number in parentheses shows standard error and Log likelihood is 48.942.

This result is consistent with literature such as Gjini and Kukeli (2012), Ang (2009), Hatano (2010), Erden and Holcombe (2006), Rashid (2006), Mitra (2006), Naqvi (2002), Hassan *et al.* (2011), Pereira (2001), Mitnik and Neumann (2001), Monadjemi and Huh (1998), and Erenburg (1993). Our results are in support of accelerator theory of investment which indicates that the increase in growth because of public investment further attracts investor to invest by enhancing their confidence in the economy. Thus, private investment increases. Public investment in social and physical infrastructure will lead to increase the capital productivity, availability of resources and increase in output. This channel of public investment crowd in private investment. Initially, private investors can be hesitant due to uncertainty and risk. There is a need for more public investment to facilitate and encourage the confidence of the private investors. So public investment not only crowd in private investment but also enhances the capital productivity (Hyder & Ahmed, 2004).

Table 5.6 shows the cointegration results of public investment and private investment for Transport and Communication sector.

**Table 5.6: Johansen Cointegration in Transport and Communication Sector**

Hypothesis		Eigen value	Trace Statistics	0.05 Critical Value	Prob.***
$H_0$	$H_A$				
$r = 0$	$r > 0$	0.580	41.398	15.494	0.000
$r \geq 1$	$r > 1$	0.153	6.681	3.841	0.009

The result of trace statistics show that there are two cointegration vectors. Overall, the public investment and private investment has long run relationship. Table 5.7 gives the normalized estimated coefficient of public investment, which is positive.

**Table 5.7: Normalised Cointegration Coefficient for Transport and Communication**

Private Investment	Public investment
1.000	1.003 (0.098)

Note: Number in parentheses shows standard error and Log likelihood is 5.535.

This shows that the increase of public investment in Transport and Communication sector leads to increase the private investment in this sector. The increase in investment in Transport and Communication sector through technology advancement increases the competition as well as profit. The major public airline is PIA. Private sector airline industry get the benefit through competition like Air Blue, Aero Asia and Shaheen Airline. Public investment in road networks like expressways and motorways also substantially increases private investment in transport such as Daewoo which delivered successful service with consumer's affordability and choice. The wide spread and improved road networks provide opportunities for various small scale investments. The major international trade is handled by Port Qasim and Karachi Port. Moreover, the

establishment of Gwadar Port also enhanced the trade opportunities and pointing to progress into a dominant energy port in the region. The investment in Pakistan Post to provide better quality and variety of services and increases the competition among private courier services like TCS, DHL and Leopards etc. As a result private investment also increases. It shows that if public investment is done in productive manner then it will boost more private investment. Our results are consistent with the study of Hassan *et al.* (2011), Bose and Haque (2005), Easterly and Rebelo (1993), Lucas (1988).

The results of Table 5.8 indicates that there is long run relationship between public investment and private investment in Mining and Quarrying sector.

**Table 5.8: Johansen Cointegration for Mining and Quarrying Sector**

Hypothesis		Eigen value	Trace Statistics	0.05 Critical value	Prob.***
$H_0$	$H_A$				
$r = 0$	$r > 0$	0.530	35.433	18.397	0.000
$r \geq 1$	$r > 1$	0.122	5.212	3.841	0.022

The result in Table 5.9 indicates the estimated coefficient of public investment in Mining and Quarrying sector is positive, which explains that the one percent increase in public investment leads to 1.71 percent increase in private investment. Most of the mining reserves are in remote areas of the country so better infrastructure appeal private investors for investment. Moreover, the government has announced a policy in 2000 in which the importation of machines are free of tariffs.

**Table 5.9: Normalised Cointegration Coefficient Mining and Quarrying Sector**

Private Investment	Public investment
1.000	1.718 (0.221)

Note: Number in parentheses shows standard error and Log likelihood is -39.119.

Hence, this also increases investment in Mining and Quarrying sector. These results are consistent with literature like Sohail, Huang, Bailey, Akhtar, and Talib (2013), Murty and Soumya (2011), and Azapagic (2004). Table 5.10 shows that there is one cointegrating equation at 5 percent. It shows that there exist long run relationship between public and private investment in manufacturing sector.

**Table 5.10: Johansen Cointegration of Manufacturing Sector**

Hypothesis		Eigen value	Trace Statistics	0.05 Critical value	Prob.***
$H_0$	$H_A$				
$r = 0$	$r > 0$	0.452	24.522	15.494	0.001
$r \geq 1$	$r > 1$	0.001	0.042	3.841	0.835

The result in Table 5.11 presents the normalised coefficient of public investment that is 0.35, which is positive. It explains that the 1 percent increase in public investment in manufacturing sector leads to 0.35 percent increase in private investment in this sector. This result indicates that public investment is complementary for private investment in manufacturing sector. The public investment focuses to improve the technology, management skills, availability of credit and competition in small and medium term enterprises.

**Table 5.11: Normalised Cointegration Coefficient for Manufacturing Sector**

Private Investment	Public investment
1.000	0.353 (0.049)

Note: Number in parentheses shows standard error and Log likelihood is -16.795.

This leads to increase the competition in private investment in small and medium enterprises. Hence, private investment increases in this sector. The results present in Table 5.10 and 5.11 are consistent with literature like Xu and Yan (2014), Murty and Soumya (2011), and Pereira (2001).

The results of Johansen cointegration for Finance sector are presented in Table 5.12. There exist one cointegrating vector. It mean there is long run relationship between public investment and private investment in Finance sector.

**Table 5.12: Johansen Cointegration for Finance Sector**

Hypothesis		Eigenvalue	Trace Statistics	0.05 Critical value	Prob.***
$H_0$	$H_A$				
$r = 0$	$r > 0$	0.487	30.355	15.494	0.000
$r \geq 1$	$r > 1$	0.070	2.986	3.841	0.084

The result in Table 5.13 presents the normalised coefficient of public investment in Finance sector. The coefficient of public investment has positive sign with value of 0.018, this shows that the 1 percent increase in public investment in finance sector leads to 0.018 percent increase in private investment; this result indicates that public investment crowds in private investment in Finance sector. But the coefficient is statistically not significant.

**Table 5.13: Normalised Cointegration Coefficient for Finance Sector**

Private Investment	Public investment
1.000	0.018 (0.205)

**Note:** Number in parentheses shows standard error and Log likelihood is -57.773.

The development in financial sector can enhance the saving rate in the economy which increases private investment due to availability of funds.

The results in Table 5.14 report that there is long run relationship between public and private investment in construction sector. The null hypothesis of no cointegrating equation is rejected and the null hypothesis of at most one cointegrating equation is accepted. It means that there exist one cointegrating vector.

**Table 5.14: Johansen Cointegration for Construction Sector**

Hypothesis		Eigen value	Trace Statistics	0.05 Critical value	Prob.**
$H_0$	$H_A$				
$r = 0$	$r > 0$	0.218	12.93	12.320	0.039
$r \geq 1$	$r > 1$	0.066	4.072	4.129	0.113

The coefficient of public investment in construction sector has positive sign with a value of is 0.589. Table 5.15 result shows that the public investment in construction sector has crowded in private investment in construction sector. The increase in public investment in construction sector may be done for restoration activities of government for earth quake and flood stricken areas and due to high profit incentive that have encouraged private investment in construction sector.

**Table 5.15: Normalised Cointegration Coefficient for Construction Sector**

Private Investment	Public investment
1.000	0.589 (0.212)

Note: Number in parentheses are standard error and Log likelihood is -23.934

According to *World Bank report* (2008) that the construction sector has the capability to generate the return on investment five time greater than the cost of investment. Public investment complement private investment in construction sector. Our results are in line with literature like Donaubauer, Meyer, and Nunnenkamp (2015) Fujii *et al.* (2013), Ozkan and Ozkan (2012).

In agriculture sector the evidence of cointegration exists which is presented in table 5.16 the null hypothesis of no cointegrating equation and the null hypothesis of one cointegrating equation is rejected because the probability is less than 5 percent. It means that there are two cointegrating equations. We considered one cointegrating equation on the base of highest eigenvalue. Moreover, there is long run relationship between public and private investment in agriculture sector.

**Table 5.16: Johansen Cointegration for Agriculture Sector**

Hypothesis		Eigenvalue	Trace Statistics	0.05 Critical value	Prob.**
$H_0$	$H_A$				
$r = 0$	$r > 0$	0.531	37.502	15.494	0.000
$r \geq 1$	$r > 1$	0.414	15.541	3.481	0.000

The result of normalized cointegration is presented in Table 5.17 the positive relationship exists between public investment and private investment in agriculture sector.

**Table 5.17: Normalised Cointegration Coefficient for Agriculture Sector**

Private Investment	Public investment
1.000	0.667 (0.149)

Note: Number in parentheses show standard error and Log likelihood is -22.634.

The positive relationship is due to availability of good quality seeds and fertilizers through public investment increase the productivity and as a result it will encourage the private investment. The crowding in is consistent with literature e.g., Murty and Soumya (2011), Ahmad and Qayyum (2008a), Saeed *et al.* (2006), and Pereira (2001).

### 5.5. Results of Variance Decompositions

Table 5.18 summarizes the result of the VDCs for the first logarithmic difference of public and private investment for the period up to 6 years at aggregate as well as sector level. It shows that effect of public investment shocks on forecast error variance of private investment at aggregate level and for six sectors of Pakistan economy.



**Table 5.18: Variance Decomposition of Private Investment**

<b>Private Investment at Aggregate Level</b>		
<b>Forecast Horizon</b>	<b>Public Investment</b>	<b>Private Investment</b>
1	0.140	99.859
2	0.663	99.336
3	0.757	99.242
4	0.775	99.224
5	1.570	98.429
6	2.663	97.336
<b>Private Investment in Transport and Communication</b>		
<b>Forecast Horizon</b>	<b>Public Investment</b>	<b>Private Investment</b>
1	23.934	76.065
2	39.267	60.732
3	52.426	47.573
4	62.740	37.259
5	67.368	32.631
6	68.714	31.285
<b>Private Investment in Mining and Quarrying</b>		
<b>Forecast Horizon</b>	<b>Public Investment</b>	<b>Private Investment</b>
1	11.938	88.061
2	15.236	84.763
3	19.527	80.472
4	21.738	78.261
5	23.160	76.839

6	24.555	75.444
<b>Private Investment in Manufacturing</b>		
<b>Forecast Horizon</b>	<b>Public Investment</b>	<b>Private Investment</b>
1	1.610	98.389
2	2.444	97.555
3	2.539	97.460
4	7.368	92.631
5	11.070	88.929
6	12.950	87.049
<b>Private Investment in Finance</b>		
<b>Forecast Horizon</b>	<b>Public Investment</b>	<b>Private Investment</b>
1	26.626	73.373
2	37.117	62.882
3	36.916	63.083
4	35.906	64.093
5	39.454	60.545
6	39.640	60.359
<b>Private Investment in Construction</b>		
<b>Forecast Horizon</b>	<b>Public Investment</b>	<b>Private Investment</b>
1	0.939	99.060
2	2.104	97.895
3	2.212	97.787
4	2.810	97.189
5	3.324	96.675

6	3.904	96.095
<b>Private Investment in Agriculture</b>		
<b>Forecast Horizon</b>	<b>Public Investment</b>	<b>Private Investment</b>
1	0.803	99.196
2	1.301	98.698
3	15.435	84.564
4	17.285	82.714
5	16.358	83.641
6	14.148	85.851

The estimates of variance decomposition show increasing trend. In Transport and Communication sector, the size of estimates are high compared to other sectors. Finance sector and Mining and Quarrying sector also has increasing trend. However, the size of estimates are unexpectedly low at aggregate level and in Manufacturing sector, Construction sector and Agriculture sector. In general, it can be concluded that public investment seems a relatively less important variables in explaining forecast error variance of private investment at aggregate level as well as sector level. Though, coefficients of variance decompositions provide information about the importance of variable but do not offer insight about the direction of response of variables to certain shocks. These results are consistent with Rashid (2006), Monadjemi and Huh (1998).

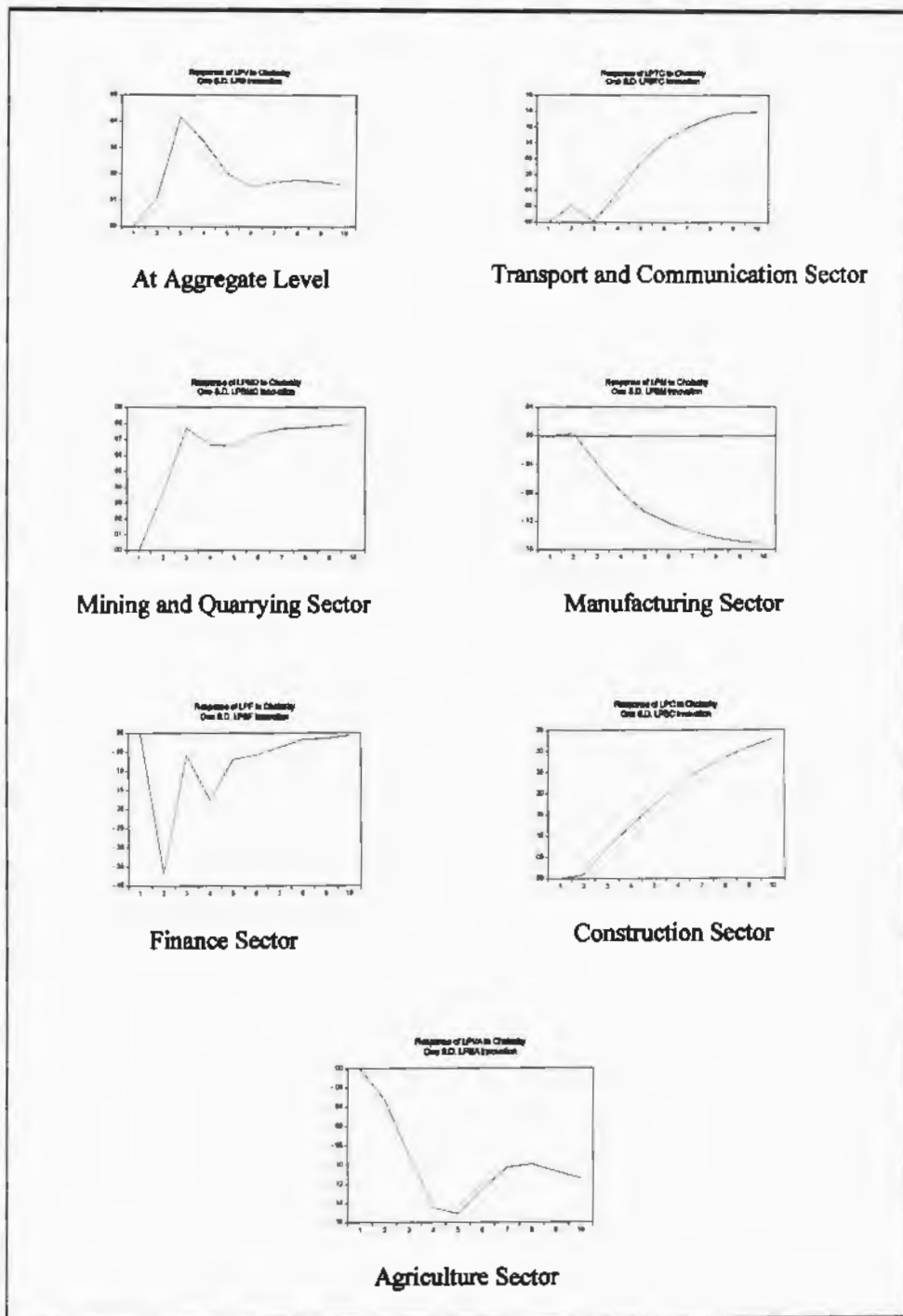
#### **5.6. Results of Impulse Response Function**

The impulse response function (IRF) is used to investigate the dynamic response of private investment to one standard deviation shock to public investment. The response may be positive or negative.

Figure 5.1 demonstrates the response of private investment when one standard deviation shock is given to public investment at aggregate level as well as sectoral level. With one standard deviation shock to public investment the response of private investment at aggregate level is that the entire confidence interval is above zero. At the beginning it starts to increase till the third period after third period it starts to decrease and decreasing trend is observed till 6th period and after that it has a constant trend. This means it supports the crowding in effect. Transport and Communication sector, Construction sector and Mining and Quarrying sector also support the crowding in because the impulse response function is above zero. However, the impulse response function in these sectors (Transport and Communication sector, Construction sector and Mining and Quarrying sector) do not intersect the zero line that is why they show significant positive effect on private investment (Al-Abdulrazag, 2010; Monadjemi & Huh, 1998).

In Transport and Communication sector the response of private investment is increasing at slow rate but after 1<sup>st</sup> period it starts to decrease but this decrease will continue till 2.5 periods. However, after two and half years the response of private investment in Transport and Communication sector starts to increase at high rate and this increasing trend is observed till the 9<sup>th</sup> period. In Mining and Quarrying sector the response of private investment in first period is increasing at very high rate but this increasing trend is observed till the second period.

**Figure 5.1 Response of Private Investment to one S.D Innovation  $\pm 2S.E.$**



After 2<sup>nd</sup> period the response of private investment to shock is diminishing till fourth period after that the response to shock is constant. In Construction sector the response of private investment to one standard deviation shock in public investment is positive and increasing.

The negative response of private investment to one standard deviation shock to public investment observed in Manufacturing, Finance and Agriculture sector. This show the crowding out effect of private investment to shock in public investment. But in the case of Manufacturing sector the response of private investment to shock is insignificant because the response function intersect the zero line. To sum up, at aggregate level and three sectors (Transport and Communication, Mining and Quarrying and Construction) show crowding in effect, two sectors (Finance and Agriculture) clearly show crowding out effect of private investment due to shock in public Investment. One sector that is Manufacturing sector show the insignificant results.

### **5.7. Vector Error Correction Model**

A vector error correction model inspect the existence of equilibrium or disequilibrium between long run and short run dynamics. The advantage of an ECM representation is that it incorporates both the long run and short run relationship among the concerned variables in the identical regression (Engle & Granger, 1987). In this section we estimate the vector error correction model for aggregate level as well as for sectors, which we used in this study. Table 5.19 demonstrates the vector error correction for public and private investment at aggregate level. The table consists of three columns, in first column we have mentioned the variables namely private investment, public investment, interest rate and gross domestic product, in 2<sup>nd</sup> column we have the values of coefficients of variables and in third column we have standard error. The

significance of coefficient is determined by t-values. Which is obtained by dividing coefficient available by its relevant standard error.

**Table 5.19: Vector Error Correction Model for Aggregate Level**

Variables	Coefficient	Standard Error
EC(-1)	-0.449**	0.210
$\Delta$ lpv(-1)	0.200	0.228
$\Delta$ lpv(-2)	-0.183	0.194
$\Delta$ lpb(-1)	0.044	0.132
$\Delta$ lpb(-2)	0.128	0.141
C	-4.304*	2.113
Dl GDP	0.599**	0.280
Di	0.001	0.010
Chi-square <sup>a</sup> = 2.469 Prob = 48%		R-Squared = 0.31 F-Statistics = 3.45 Prob = 0.021

**Note<sup>a</sup>:** Wald test for joint significant of lagged differences of public investment.

The coefficient of error correction term EC (-1) is statistically significant with negative sign that is theoretically correct sign. Fatima (2012), Saghir and Khan (2012), Asari *et al.* (2011), Ahmad and Qayyum (2008b), Erden and Holcombe (2006), and Laopodis (2001) also obtained similar results and significant value of coefficient of error correction term with negative sign indicates that a short term variation will lead to establish a long run relationship among variables. On the basis of this justification our

results show long run relationship between public investment and private investment at aggregate level. The coefficient also shows that the adjustment towards equilibrium in next year will be at the speed of 45 percent. Moreover, the short run relation is positive but insignificant in case of public investment and private investment. The lagged coefficient of public investment are insignificant at individual level. Moreover, the results of Wald test given in second last row of table 5.19 for the joint impact are also insignificant that indicate there is no short run and long run relationship between public investment and private investment. This shows that public investment does not affect the private investment in short run at aggregate level. The coefficient of output is positive and significant which shows that output is positively affecting private investment in short run. The coefficient of interest rate is positive but insignificant which shows that interest rate is not the significant determinant of private investment. Other factors like future prospect and growth potential, political stability are also important in determining the aggregate behavior of private investment. The R-squared is 31.03 percent and probability of F-statistics is 0.047 percent and F-statistic is significant. Our results at aggregate level show crowding in of private investment which are consistent with extensive part of pervious literature like Xu and Yan (2014), Ang (2009), Hatano (2010), Hussain *et al.* (2009), Rashid (2006), Pereira (2001), and Erenburg (1993).

Table 5.20 reports the results of vector error correction model for Transport and Communication sector. The error correction term EC (-1) is negative and significant. This shows that the long run relationship exists between public and private investment in Transport and Communication sector. Therefore, the speed of adjustment is 54.1 percent of private investment to attain the equilibrium in coming year. The coefficient of public investment is positive and significant in two lags. When we checked the joint



impact of both lags that is also significant which is confirmed from chi-square value. This means that public investment in Transport and Communication crowds in private investment in the same sector. The coefficient of  $t$  is negative but insignificant.

**Table 5.20: Vector Error Correction in Transport and Communication Sector**

Variables	Coefficient	Standard Error
EC(-1)	-0.541***	0.169
$\Delta lptc(-1)$	0.542***	0.174
$\Delta lptc(-2)$	0.418**	0.184
$\Delta lpbtc(-1)$	0.284**	0.134
$\Delta lpbtc(-2)$	0.144	0.144
C	-8.344***	2.703
$D_i$	-0.011	0.015
$Dl_{gdp}$	1.150***	0.361
Chi-square <sup>a</sup> = 4.48 Prob = 10.0%		R-Squared = 0.33 F-Statistics = 2.345 Prob = 0.047

Note<sup>a</sup>: Wald test for joint significant of lagged differences of public investment.

However, the coefficient of output is positive and significant. It means that interest rate does not have any short term effect on private investment. But output has, with the increase of output private investment also increases. The R-squared is 33.91 and probability of F-statistics is 0.047 percent. Our result are in line with the study of Hassan *et al.* (2011).

Table 5.21 provide the result of vector error correction model of Mining and Quarrying sector. The error correction term is negative and significant which shows that there exists a long run relation between public investment and private investment in Mining and Quarrying sector and the speed of convergence to equilibrium is 26 percent. In coming year 26 percent of disequilibrium is corrected in this sector.

**Table 5.21: Vector Error Correction of Mining and Quarrying Sector**

Variables	Coefficient	Standard Error
EC(-1)	-0.259**	0.126
$\Delta$ lpmq(-1)	-0.025	0.205
$\Delta$ lpmq(-2)	-0.117	0.193
$\Delta$ lpbmq(-1)	0.359**	0.166
$\Delta$ lpbmq(-2)	0.310*	0.154
C	-7.796**	3.631
Di	0.021	0.028
Dgdp	1.092**	0.503
Chi-square <sup>a</sup> = 7.605 Prob = 5.4%		R-Squared =0.39 F-Statistics =5.766 Prob = 0.012

Note\*: Wald test for joint significant of lagged differences of public investment.

The coefficients of lagged difference of public investment are positive in both lags. The joint impact of two lagged differences of public investment is checked through chi-square and it is also significant. The result depicts that there is short run relationship

between public and private investment and shows the short run crowding in effect in this sector investment. Moreover,  $i$  is positive but insignificant. However, the coefficient of output is positive and significant. This shows that with the increase of output investment also increases.

**Table 5.22: Vector Error Correction for Manufacturing Sector**

Variables	Coefficient	Standard Error
EC(-1)	-0.002**	0.001
$\Delta lpm(-1)$	0.319	0.195
$\Delta lpm(-2)$	-0.253	0.159
$\Delta lpbm(-1)$	0.097***	0.030
$\Delta lpbm(-2)$	-0.016	0.028
C	0.037	0.116
Di	-0.053***	0.018
Dlgdp	0.117	0.011
<b>Chi-square<sup>a</sup> = 24.75</b> <b>Prob = 0.01%</b>		<b>R-Squared = 0.56</b> <b>F-Statistics = 3.066</b> <b>Prob = 0.009</b>

Note<sup>a</sup>: Wald test for joint significant of lagged differences of public investment.

The results in above table shows that EC(-1) is negative and significant at 1 percent. The coefficient of lagged difference in public investment is positive and significant at first lag and significant the second lag is insignificant. The joint impact of two lagged difference of public investment is significant because the probability is less than 1 percent indicating that public investment in Manufacturing sector positively affects

short run private investment in this sector. The above empirical result show that public investment and private investment have long run and short run relationship and crowding in effect occur for private investment in Manufacturing sector. The coefficient of interest rate is negative and significant. It mean that interest rate negatively affect private investment. The coefficient of output is insignificant. The value of R-squared is 56 percent and probability of F-statistics is significant. Our results are consistent with the study of Pereira (2001).

**Table 5.23: Vector Error Correction for Finance Sector**

<b>Variables</b>	<b>Coefficient</b>	<b>Standard Error</b>
<b>EC(-1)</b>	-0.056	0.098
<b><math>\Delta</math>lpf(-1)</b>	-0.156	0.175
<b><math>\Delta</math>lpf(-2)</b>	-0.356	0.201
<b><math>\Delta</math>lpbf(-1)</b>	-0.775	0.216
<b><math>\Delta</math>lpbf(-2)</b>	0.168	0.318
<b>C</b>	0.632	0.382
<b>Di</b>	0.074	0.067
<b>Dlgdp</b>	-1.067	2.635
<b>Chi-sqaure<sup>a</sup>=13.13 Prob=01%</b>		<b>R-Squared = 0.46 F-Statistics = 3.917 Prob = 0.003</b>

**Note<sup>a</sup>:** Wald test for joint significant of lagged differences of public investment.

The result in Table 5.23 shows that  $EC(-1)$  the coefficient of one lagged of error correction term is negative and but not significant. The coefficient of lagged difference in public investment is significant and negative but second lag is insignificant. The joint impact of two lagged difference of public investment is significant. Our results indicates that public investment in finance sector is substitute nature and therefore crowds out private investment. So in short run public investment in Finance sector seems competing directly with private investment in this sector. The coefficient of interest rate, output and private investment is positive but not significant. This show that output and interest rate have not effect on private investment. The R-squared is 46 percent and probability of F-statistics is also significant.

The results presented in Table 5.24 shows that  $EC(-1)$  is negative and significant which shows that there exists long run relationship between public and private investment in Construction sector. The negative sign of  $EC(-1)$  show that the disequilibrium is converges to equilibrium with the speed of 12 percent. The coefficients of lagged difference public investment, interest rate and output are not significant. It mean that there is no short run relation exist between private investment and public investment. Output and interest rate also have no impact on private investment. The R-squared is 25 percent and probability of F-statistics is also significant at 10 percent level of significance.

**Table 5.24: Vector Error Correction for Construction Sector**

<b>Variables</b>	<b>Coefficient</b>	<b>Standard Error</b>
EC(-1)	-0.125**	0.054
$\Delta lpc(-1)$	-0.240	0.159
$\Delta lpc(-2)$	0.046	0.170
$\Delta lpb(-1)$	-0.257	0.217
$\Delta lpb(-2)$	-0.072	0.219
C	0.272	0.232
Di	0.070*	0.040
Dl GDP	-0.285	1.54
<b>Chi-square<sup>a</sup>=1.401</b> <b>Prob=49.6%</b>		<b>R-Squared = 0.25</b> <b>F-Statistics = 2.059</b> <b>Prob = 0.094</b>

**Note<sup>a</sup>:** Wald test for joint significant of lagged differences of public investment.

The results of vector error correction model for Agriculture sector are described in table 5.25. The EC(-1) is negative and significant that is theoretically correct sign. The convergent to equilibrium in coming year occurs with the speed of 23 percent. The coefficient of lagged difference of public investment in agriculture sector is positive significant in both lags.

**Table 5.25: Vector Error Correction Model for Agriculture Sector**

Variables	Coefficient	Standard Error
EC(-1)	-0.226**	0.113
$\Delta$ lpa(-1)	-0.471*	0.238
$\Delta$ lpa(-2)	-0.324	0.274
$\Delta$ lpba(-1)	0.230*	0.125
$\Delta$ lpba(-2)	0.341***	0.100
C	0.433***	0.247
Di	-0.006	0.028
Dl GDP	3.035**	1.429
Chi-square <sup>a</sup> =12.281 F-Statistics = 4.588 Prob=0.2%		R-Squared = 0.60 Prob = 0.003

Note<sup>a</sup>: Wald test for joint significant of lagged differences of public investment.

The coefficient of interest rate is negative and insignificant. The coefficient of output is positive and significant. It means output has a positive effect on private investment in the Agriculture sector. Our empirical results are consistent with the studies of Saeed *et al.* (2006).

Crowding in and crowding out exist globally. In this section we investigate public investment and private investment at aggregate level and sectoral level in Pakistan. Overall, our results suggest that crowding in phenomena exist at aggregate level as well as sectoral level in Pakistan during the examined period. In order to check the

relationship between public investment and private investment at aggregate level. We use Johansen cointegration to check the long run relation among public investment and private investment. Then, we use impulse response function and variance decomposition to check the dynamic effect of shock. To check the short run as well as long run we use VECM. Our results prove that there is positive relation exist between public investment and private investment. This implies that with the increase of public investment private investment also increase.

Turning to the results of sectoral level, by using Johansen cointegration we find that all sectors are cointegrated, this show that they have long run relation exist among considered variables. Thus, we conclude that with the increase of public investment private investment also increases. Said differently, in Pakistan there is complementary relation exist between public investment and private investment. By using the impulse response function, three sectors namely (Transport and Communication, Mining and Quarrying, Construction sector) show the crowding in effect of public investment on private investment and three sector namely (Manufacturing, Finance and Agriculture sector) show crowding out effect and in Pakistan. However, the results from variance decomposition estimates indicate the weak evidence of the response of private investment due to shock in public investment. Our results are also consistent with Rashid (2006).

In order to check the short run as well as the long run relation between public investment and private investment. We use VECM. The results show that the four sectors namely (Transport and Communication, Mining and Quarrying, Manufacturing and Agriculture) show the significant positive short run relationship exist between public investment and private investment. However, two sectors namely (Finance and



Construction) have insignificant short run relationship between public investment and private investment.

## **Chapter 6**

### **Conclusion**

#### **6.1. Summary of Thesis**

Reviewing the most of the empirical literature, we observed that most of the prior studies regarding the relationship between public investment and private investment were at aggregate level. Moreover, few studies were found on disaggregate level but mostly they consider one or two sectors in Pakistan. This study is comprehensive examination of six sector of Pakistan economy. In particular, the first objective of our study is to check the link between public investment and private investment in six sector as well as at aggregate level. The second objective is to investigate how the effect of public investment on private investment different across different sectors in short run and long run. To do so, we use annual data over the period 1971 to 2013.

#### **6.2. Summary of Findings**

In this study, we examine how public investment affect private investment at aggregate level as well as sectoral level in Pakistan. Specifically, we investigate that how public investment in a particular sector affects the private investment in same sector. In this study we take six sectors to examine the link between public investment and private investment. The outcomes of this study shows that on aggregate level public investment increase private investment. The empirical results of the Johansen cointegration shows that at aggregate level, there exists a significant positive long run relationship between public investment and private investment. Our results support the crowd in private investment due to public investment. The justification of crowding in is that public investment and private investment differ from each other. Private investment is on

profit seeking basis, while public investment is generally for the welfare and development of the country. Moreover, public invest in long-term and in risky projects. However, private investors do not participate normally in long term and risky projects. It indicates that public and private investment in most of sectors is not in joint ventures except finance sector where results are insignificant so public and private investors do not compete with each other that's why public investment and private investment seem complementary to each other. The results are also consistent with the findings of existing empirical studies, such as like Xu and Yan (2014), Ang (2011), Hatano (2010), Hussain *et al.* (2009), Rashid (2006) and Pereira and Alfredo (2001), that show that more public investment leads to increase more private investment.

The sectoral analysis of linkage between public and private investment indicate that out of six sectors five indicated the existence of positive relationship between public and private investments. These sectors are Transport and Communication sector, Mining and Quarrying sector, Manufacturing sector, Agriculture sector and Construction sector. In case of Finance sector our results support significant negative short run relationship but insignificant positive relationship.

The sectoral analysis shows that the speed of convergence is higher in Transport and Communication sector and the lower speed of convergence is observed in Manufacturing sector. The Wald test indicates that the strongest positive short run relationship is observed in Manufacturing sector while, in Construction sector and at aggregate level this relationship is positive but insignificant and negatively insignificant in Finance sector. However, the insignificant is observed in Construction sector.

### **6.3. Policy Recommendations**

From the policy point of view, this study would be beneficial to private investor as well as for government for investment decisions. In other words, our study is helpful for the policy makers in designing the investment policies. The findings of this study also suggest that public investment particularly at aggregate level as well as at sectoral level increases the private investment in same sectors namely, Transport and Communication sector, Mining and Quarrying sector, Manufacturing sector, Construction sector and Agriculture sector. Government of Pakistan should increase investment in these sectors which are mentioned above as it facilitates private investment and should reduce public investment in Finance sector as it directly competes with private investment. The role of government should be of an organizer rather than administrator which will boost the confidence of private investor for more investment. Continue increase in private investment is an expression of the competent government policies that is helpful in reducing the cost of capital for private investors. Moreover, our study helps the policy makers in stabilizing and strengthening the investment in Pakistan.

### **6.4. Limitations and Future Area for Research**

Although the focus of this study is to examine the public and private investment linkages in different sectors as well as aggregate level in Pakistan. Apart from this, we would like to propose more extensive study to improve and enhance the existing literature related to investigating the public and private investment linkages in Pakistan. In fact, there is remarkable area to improve this study through many ways:

- This study can be done by using industry level data instead of sectoral level data.

- This empirical analysis can also be perform on cross county basis to analyze the difference in the behavior of public and private investment in different sectors across different countries which may help to design appropriate polices to strengthen the sectoral performance of our country's results obtained by cross country analysis.

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