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INVESTMENT IN AGRICULTURE SECTOR AND PROSPECTS FOR CHANGE: A SEM PERSPECTIVE FOR PAKISTAN

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Abstract: Agriculture is considered an integral part of the economy of Pakistan due to its support for a large chunk of the working population. Despite this, there is still inertia in the sector due to its persistently declining share in output, which demands a substantial investment. However, investment and specifically public investment in the sector, has been diminishing over the years. Conversely, private investment exhibits a slow yet increasing trend in agriculture. This has intuited to perform an analysis covering both conceptual and empirical aspects to figure out the prospects for change in the agriculture sector of Pakistan in the context of investment. This study is an endeavour to explore the simultaneity of the relevant determinants of the agriculture sector in Pakistan considering the Simultaneous Equation Model (SEM) approach from 1981-2018. The study has employed the Three Stage Least Square (3SLS) estimation technique to incorporate the simultaneity of five endogenous variables: private investment in agriculture, pubic investment in agriculture, mechanization in agriculture, agriculture GDP and employment. The other variables are infrastructure, institutional credit, rain, net area sown, improved seed distribution and rural population. The SEM perspective in the study provided an intuition that there is a dire need to develop a compact plan considering the agriculture sector's investment, productivity, mechanization and employment. Further, public-private complementarity in the sector would foster rural development in compliance with the improvement in social heads through creating more employment and better wages to create a "win-win" strategy. Virtually, the prospects of change have been prescribed in the context of agricultural advancement in Pakistan, which has the potential to turn the historical patterns into unprecedented growth of the economy.

Keywords: Public Investment, Private Investment, Productivity, Agri-Mechanization, Employment, SEM Perspective, Endogenous

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1. INTRODUCTION

1.1. Background of the Study

The economics of agriculture development associates rapid economic growth with the transition in systems of the agriculture sector (Mishra, 2019). Considering the virtual cases of the past, it is evident from the histories of Europe, North America and East Asia in the 18th, 19th and 20th centuries, respectively. This transformation has been attained through productivity enhancement, food processing, and storage improvement with noticeable cost reduction outlays. Further, advancements in food distribution improved the quality, quantity, variety, safety and availability of food at relatively low prices (Barrett, 2011). Traditionally, this agricultural development is rudimentary for two apparent reasons. First, the sector serves as a good source of input for an economy's food and industrial needs (Baba, Saini, Sharma, & Thakur, 2010). Second, it promotes employment, self-reliance and poverty alleviation (Desai & Namboodiri, 1998). Therefore, the failure of economies to accomplish such advancements has been widely associated with various institutional and non-institutional impediments. Hence, contemporary research on the agriculture sector revolves around exploiting the development process in the sector.

Following the traditional patterns of developing economies, the economic structure of Pakistan revolves around its agriculture sector. However, despite being an integral part of the economy, the sector still needs to catch up in terms of growth and development as compared to the other sectors of the economy. According to the Pakistan Economic Survey (PES) 2018-19, the agriculture sector grew by 0.85 per cent to the targeted 3.8 per cent in comparison with the industrial (1.40 per cent) and services sectors (4.71 per cent) during the last fiscal year. Consequently, this sluggish yet declining growth of the agriculture sector is a severe concern to policy think tanks, as the sector has innumerable backward and forward linkages. These demands a need for sufficient investment opportunities in order to bring out the agriculture sector from its inertia to the development phase. In this context, private and public investments are essential to raising the productive capacity of the agriculture sector through technological progress (Ahmad & Qayyum, 2008).

1.2. Investment Trends in the Agriculture Sector of Pakistan

Over the past two decades, the agriculture sector of Pakistan has undergone vital policy and technological transformations. The changes were implemented

through production incentives, accessibility to high-quality fertilizers, water availability and credit etc., that were well represented in surplus outputs and self-sufficiency of the economy in food. However, despite this, there is emerging consensus on the prospects of the agriculture sector in Pakistan as the declining trend in the growth of the sector has been transmuted to the exports of the food group showing a negative growth change (2.40 per cent) in the current fiscal year (PES, 2018-19). This could be due to the significant traditional impediments faced by the sector in Pakistan, including inadequate funds, land-tenure issues, water resource management loopholes, and incompatible pricing strategies. Here, a critical query demands an explanation for the deteriorating performance of the agriculture sector. Looney (1999) pointed out that the sector's issues had induced the government of Pakistan (GoP) to withdraw its part and move towards market-based strategies. Hence, over the last few years, the private sector has been supposed to fulfil essential capital requirements while public investment primarily furnishes the rudimentary infrastructure needs (Looney & Winterford, 1992). Meanwhile, there is also a quandary perspective which raises questions on the willingness of the private sector to facilitate the agriculture sector given the changing policy scenarios.

Given these insights, the trends in public and private investments are elucidated in Figure 1. The figure portrays that public investment in the sector experienced an irregular pattern over the past years while it follows a decline in later years of the 20th century with an overall declining trend.

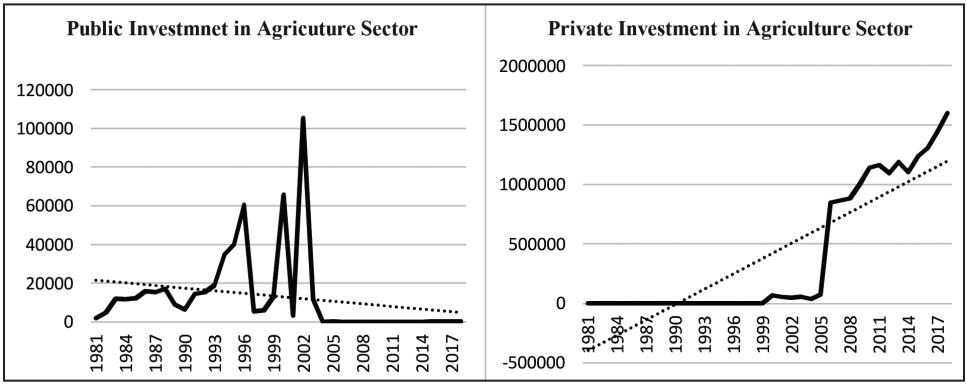

Figure 1: Public and Private Investment in Agriculture Sector (at constant prices of 2005-06)

On the other side, private investment showed a stagnant and gradually increasing trend in the initial years while it has symmetry with an overall

positive trend. However, these trends in investments could not be used to conclude that public investment has been effectively replaced by private capital in the agriculture sector. Intuitively, it could be associated with several institutional changes in the economy of Pakistan that altered the investment priorities or climate. At the beginning of the 1970s, adopting nationalization policies discouraged private investment, while the trend reversed gradually after 1977. Whereas, at the end of the 1980s, the privatization efforts failed due to persistent budget deficits and worsened balance of payment. This resulted in assistance from the International Monetary Fund (IMF) in the form of Structural Adjustment Programmes (SAPs). In the 1990s, government policies surged momentum in private investment due to the announcement of a new power market for the agriculture sector. In this era, many initiatives had been taken to enhance agricultural productivity, including price concessions in agricultural machinery, price flooring incentives on selected food items, relaxations in sales taxes on selected agricultural machinery and withdrawal of custom duties. In this regard, the role of institutions responsible for credit provision in the agricultural sector was well appreciated.

Moreover, until 1997 the manufacturing sector was solely bearing the fruits of foreign investment. Later that year, the policy regime allowed to include agriculture, services and social sectors in the liberalized bracket. Moreover, Corporate Agriculture Farming (CAF) initiative was implemented in 2004. However, that still needs to be compatible with traditional rural farming. Further, in subsequent years, various other fiscal incentives were introduced to induct capital in the agriculture sector, including establishing financial institutions, exemption on oil imports, customs duties and so on. This regained investors' confidence, and thus, after 2005, the agriculture sector experienced an increasingly positive trend in private investment. Hence, the policies of different governments favour different investment strategies throughout the years.

Hence, the declining public investment and the increasing role of the private sector in agriculture have intuited to perform a comprehensive analysis of Pakistan. There are two prime objectives of this study. First, to empirically evaluate the agriculture output model through the lens of investment (both public and private). Correspondingly, this may also assess the complementarity between the two divergent investments. Therefore, the study employed the Simultaneous Equation Model (SEM) to indulge the relevant factors of the agriculture sector in Pakistan. Second, the study's findings will be used to highlight the prospect of change for the agricultural sector of Pakistan.

2. LITERATURE REVIEW

The literature on investment or capital formation in agriculture magnifies its significance by analyzing output effects and trends and detecting complementarity between public and private investment. Precisely, the literature is multi-faceted and complex, covering numerous dimensions. In this section, we will consider relevant yet related studies that may assess to develop an insight into the existing evidence on the topic.

Initiating with the theoretical perspectives, the growth models revolve around strengthening the traditional sector and then the movement of labour and capital in modern sectors (manufacturing and services sectors). Lewis (1954) canonically modelled the growth of the agriculture sector, while Ranis and Fei (1961) successively protracted the model. Precisely, Lewis stressed imputing the surplus labour of agriculture to earn higher wages from the manufacturing sectors to ensure the economy's growth. Additionally, Schultz (1964) pointed out the relevance of the agriculture sector for food sufficiency and the economy's subsistence. However, the relatively contemporary view of Kuznet and Murphy (1966) highlighted the declining share of the agriculture sector for the growth of any economy. They primarily observed the farm economy's role in the food supply context with relatively low remunerations than the non-farm economy.

Further, he argued that development and increase in the productive capacity of the traditional sector through interconnecting its labour and capital with other sectors. Extending these verdicts, Singer (1979) developed the agriculture growth model, which could lead to industrialization. Moreover, Adelman (1984) also concentrated on the agriculture-industry linkages favouring the output and input resources. Hence, these customary studies strained on efficient use of labour and capital initially in the traditional sector and latterly in the modern sectors. However, this is different for recent economies and, specifically, developing economies.

Turning to the other related studies, extensive studies rely on capital formation due to the significant agricultural investments of the green revolution during the 1960s. Some such studies include the work of Baba et al. (2010), Chand (2001), Gulati and Bathla (2001), and Kumar Mallick (1993). Besides, a positive impact of public investment on private investment has been explored in studies by Rashid (2005), Munnel (1992), Greene and Villanueva (1991) and Aschauer (1989). Meanwhile, the negative complementarity between the two investments was found by Akkina and Celibi (2002); and Wai and Wong (1982).

Referring to the panel studies, Tatiana et al. (2015) stressed on improvement of private investment in order to address the issues of infrastructure facilities and land accessibility. Further, the authors considered private investment an essential determinant for improving the agriculture sector and the economy. Timmer (2002) also used panel data from 65 economies to explore the first-order (global markets) and second-order effects (nutritional intake) of agriculture growth. The author suggested that these effects could be further enhanced through capital formation and improvements in labour productivity—the study's findings aligned with the panel study of Self and Grabowksi (2007).

Another strand of literature observed the elements that are not related to the macro or microeconomic factors. These include war, disasters, political instability, uncertain years etc., that should not be quantified. Hence, the impact of uncertainties in the investment models had been indulged by close proxies. In this regard, most of the studies are done in the United States, including Carruth et al. (2000), Campa (1993), and Pindyck (1993). Furthermore, Fedderke (2004) also observed uncertainties in the economy of South Africa.

On the other side, the study of Anderson and Feder (2007) stressed the decentralization of the traditional agriculture systems by providing autonomy to farmers or efficient private investors for service provisions. The authors proposed that this transformation could alter the customary accountability issue of the agriculture sector in economies.

Considering the recent national studies, Ajmair (2018) parametrically found a negative association of investment (capital formation) with the sectoral growth of agriculture. However, a plausible explanation has yet to be provided by the authors for this indirect link. Meanwhile, Ahmad and Qayyum (2008) applied a dynamic modelling approach and approved the complementary association between public investment and private investment in the agriculture economy. Additionally, Looney (1999) evaluated private investment in the agriculture sector in the context of infrastructure and found an unresponsive impact of public investment. He attributed these findings to the fact that rural infrastructure needed to be prolific enough to stimulate investment and output in the agriculture sector of Pakistan. Using conventional econometric modelling, Khan and Iqbal (1994), Looney (1994), and Khan (1988) also pointed out the crowding-out effect of private investment in the agriculture sector of Pakistan.

The review of the literature in this section has provided some valuable insights. There still exists a debate about whether public investment crowds out private

investment in the sector. This could be why both investments are considered in the literature of global economies to evaluate the capital absorption of the agriculture sector. Besides, most studies related to investment in agriculture detected declining public investments. Further, at the international level, the agriculture sector is considered a helpful input resource for the modern sectors. In contrast, at the national level, investment literature could be more varied, divergent and contradictory.

3. METHODOLOGY

3.1. Conceptual Model

The conceptual model of the study in Figure 2 proposes a direct association between the productivity of the agriculture sector and investment (public and private), relating agricultural masses through mechanization and employment generation. The inclusion of investment in the simultaneous model serves three key objectives. First, the model separately considers the capital formation of both the public and private sectors to enhance agricultural output. Second, the model will assess the complementarity between public and private investment to prospect both sectors' associations. Third, investment opportunities could be produced by developing the agriculture sector with more efficient endowments of public policy initiatives.

Mechanization in agriculture is included explicitly in the model to indulge the systematic lines in the traditional sector. Moreover, an increase in the pace of mechanization would further foster private investment and productivity in the sector. Hence, improvements in agriculture productivity are expected to show a positive impact associated with agri-mechanization. Considering the prominence of the labour component in the agriculture model, farm employment has been included to capture direct (income generation) and indirect (poverty) effects showing the well-being of rural clusters. The model also includes these endogenous variables as independent variables to capture the simultaneity of the farm-related factors.

Infrastructure development is expected to show a positive effect on agricultural productivity. In contrast, farm employment is expected to deteriorate through increasing connectivity of villages to nearby towns and cities or other prospective reasons. Institutions have a considerable role in disbursing credit in the agriculture sector of Pakistan. Hence, the financial strengthening of rural multitudes has been captured through the provision of

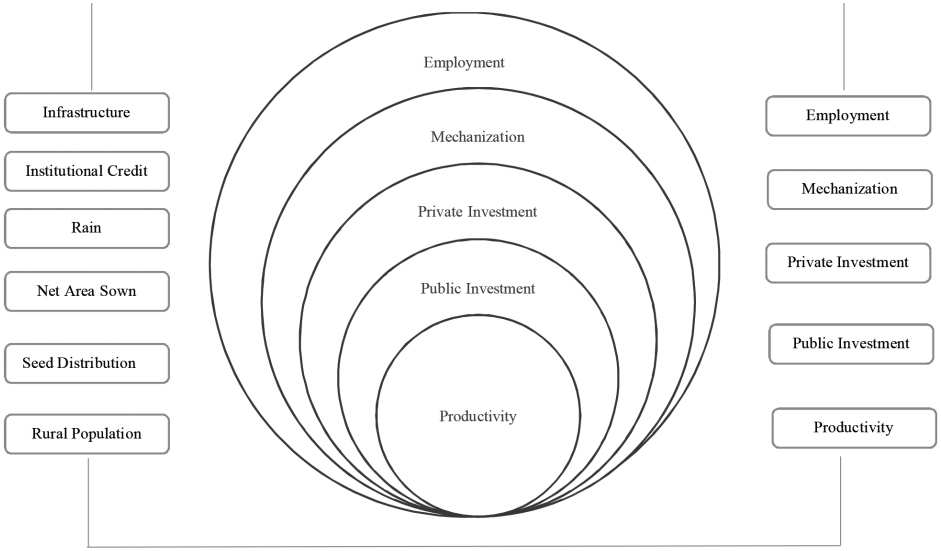

Figure 2: Conceptual Framework of the Study

Source: Illustrated by Authors

credit by agriculture credit institutions. The growth of the agriculture sector is highly attributed to the weather conditions, specifically in the form of considerable rainfall. Precisely, rainfall frequencies are responsible for water availability. Therefore, water availability has been indulged as the proxy of rain. Turning to the technical perspectives, modern inputs are reflected in increased land productivity. Therefore, net area sown and improved seed distribution is included in the model to capture the improvements in farming. On the other side, the non-economic factors have also been included to capture the comprehensive effects of the model. In this regard, the rural population has been indulged, which may, directly and indirectly, impact agricultural productivity.

The framework of the study has been designed keeping in view the identification and specification of all the variables in the model. Meanwhile, the cause-and-effect associations among the dependent variables in a system approach are essential to ensure a meaningful analysis for realistic findings (Baba et al., 2010).

3.2. Data

In this study, an initiative has endeavoured to introduce a broad series of public and private investments in the agriculture model and correspondingly, all relevant elements have been considered. The secondary data of divergent

variables has been gathered from national and international data sources from 1981-2018. Table A1 in the appendix provides a quick glimpse of variables used in the model with details of abbreviations, proxies, measurement and data sources.

3.3. Estimation Strategy

The estimation strategy of the paper has been designed into two parts. The first part indulges the econometric findings of the simultaneous equations, while the second set of estimations is related to capital efficiency.

3.4. Simultaneous Equation Model (SEM)

The economic data often exhibit a set of independent processes, leading to the application of Simultaneous Equations. Precisely, these equations contain such characteristics that may inspire to include numerous dependent variables in the same set of equations. A Simultaneous Equation Model (SEM) constitutes a system of equations when all relationships between variables are required to determine the value of at least one endogenous variable of the model. In such a scenario, including all variables in every equation is optional. Therefore, the parameter estimation of these equations differs from single equation methods. Mainly, if an association under consideration is related to a system, then few predictors are treated as stochastic and, meanwhile, are correlated with disturbance terms. This violates the vital assumption of uncorrelated explanatory and error terms of Ordinary Least squares (OLS). In case, consideration of the OLS model would provide inconsistent estimators of the model. The variables are classified into exogenous and endogenous in an SEM approach. The former variable contributes to explaining endogenous variables that are determined outside the model, while the latter shows simultaneous interactions of the model that are jointly determined.

In this study, an SEM perspective is indulged through Three Stage Least Square (3SLS) to overcome the limitations of the simultaneous bias arising from single equation procedures. This may identify the direct and indirect impact of variables in determining investment in the agriculture sector. The general structural form of a system of equations is shown in Equation 1.

$$\beta' Y_t + \Gamma' X_t \equiv \varepsilon_t \tag{1}$$

Where;

β' = *matrix of coefficients of endogenous variables (nxn)*

Y_t = *vector of endogenous variables (nx1)*

Γ' = *Matrix of coefficients of exogenous variables (nxm)*

X_t = *Vector of exogenoue variables (mx1)*

ε_t = *Vector fo error terms (nx1)*

The respective brackets show the order of the equations. Moreover, the reduced form of the model can be expressed as;

$$\beta' Y_t = -\Gamma' X_t + \varepsilon t \tag{2}$$

$$Y_t = -(\beta')_{-1} \Gamma' X_t + (\beta')_{-1\varepsilon_t} \tag{3}$$

$$Y_t = \pi' X_t \mu_t \tag{4}$$

Since β' is a non-singular matrix. It is pertinent to mention here that the reduced form in equation 4 exclusively elucidates an endogenous variable through the predestined variables and the term of stochastic disturbances. The coefficients calculated from this reduced form equation are "**Impact** or **Short Run Multipliers"** (Bhattacharya, Jain, Navrekar, & Kumar, 2013).

3.5. Model

Avoiding the single equation biases, the Three Stage Least Square (3SLS) methodology has been employed to estimate the SEM. The model consists of five endogenous variables, namely public investment (PBI), private investment (PVI), agriculture productivity or output (AGDP), agr-mechanization (AGRM) and farm employment (FEMP). The structural form of the entire system is given from equations 5 to 9.

is given from equations 5 to 9.

$$\log PBI = f(\log AGDP_{t-4}, \log INF_t, \log RPOPG_{t-3}) \tag{5}$$

$$\log PVI = f(\log PBI_{t-5}, \log AGDP_{t-4}, \log AGRM_t, \log INF_t, \log INSC_t \tag{6}$$

$$\log AGDP = f(\log PBI_{t-5}, \log PVI_{t-2}, \log AGDP_{t-4}, \log AGRM_t, \log INF_t, \log INSC_t, \log ISD_t, \log NAS_t, \log RPOPG_{t-3}, \log RAI_{t-2}) \tag{7}$$

$$\log AGRM = f(\log PBI_{t-5}, \log PVI_{t-2}, \log INF_t, \log INSC_t, \log RPOPG_{t-3}) \tag{8}$$

$$\log FEMP = f(\log PBI_{t-5}, \log PVI_{t-2}, \log AGDP_{t-4}, \log INF_t, \log INSC_t, \log RPOPG_{t-3}) \tag{9}$$

3.6. Model Specifications

- In order to avoid distortions of the price changes and to ensure uniformity in the estimation procedure, a series of constant prices has been generated at the prices of 2005-06. This exercise has been done for public investment, private investment and agriculture GDP, taking the data from 1981- 2018.
- According to Fan et al. (2000), the investment requires a long time to transform the amount into productive capital; therefore, we have used the lagged values in the model estimation. Given the lag lead effect, This would help capture the long-term effect of investment in the agriculture sector.
- Additionally, the lags of the selected variables have been finalized through a trial and error process while focusing on higher values of adjusted R square.
- All the variables have been taken in log form to estimate the elasticities of the variables in the model.

3.7. Incremental Capital Output Ratio (ICOR)

The incremental capital-output ratio (ICOR) has been employed to evaluate the association between agriculture output and capital formation. This ratio is defined as changes in the gross fixed capital formation divided by the changes in agriculture GDP. It shows the capital required to produce an incremental output unit in the agriculture sector. It also highlights the efficiency and effectiveness of gross fixed capital formation after its utilization.

In order to examine the efficiency of the capital annually, the ICOR is estimated by taking output and investment at constant prices of 2005-06 using the following ICOR formula of Kothe (2013).

$$ICOR = \frac{I_t}{Y_t Y_{t-1}}$$

Where *ICOR* denotes the incremental capital-output ratio, I_t represents the current investment in the agriculture sector. At the same time, Y_t and Y_{t-1} are the agriculture sector's current and initial output values, respectively. Besides, the values of ICOR can be used to estimate the Marginal Efficiency of capital (MEC) as the inverse of ICOR is MEC.

$$MEC = 1/ICOR$$

Moreover, we have also estimated the ICOR for divergent periods. Therefore, the following mathematical form is extracted from the study of Baba et al. (2010).

$$ICOR = \frac{I_0(1+rt)}{Y_0 g}$$

Where;

I_0 = *Initial investment*

Y_0 = *Initial output*

r = *compound growth rate of investment*

g = *compound growth rate of output*

t = *time period*

Hence, positive and small values of ICOR specify effective and efficient endowment of capital and vice versa. Meanwhile, the positive and approachable to zero value of ICOR implies greater capital efficiency to enhance the output (Kothe, 2013).

4. ESTIMATION FINDINGS

4.1. Investment and Agriculture Productivity: Simultaneous Model

The estimates of the simultaneous equations of five models applying the 3SLS procedure are presented in this section. The high values of the goodness of fit (adjusted R square) imply that all models effectively explain the systematic deviations in public investment, private investment, productivity, mechanization and employment of the agriculture sector. In the subsequent sections, we will separately discuss the determinants of endogenous variables.

4.1.1. Coefficient Estimates of Model 1 (Public Investment)

The coefficient estimates of the first model are presented in Table 1. The negative yet significant coefficient of agriculture output in the model is inconsistent with the findings of Baba et al. (2010) and Ahmad and Qayyum (2008) for India and Pakistan, respectively. This could be explained through two plausible accounts subject to the economy of Pakistan; First, this might be due to the structural transformation from agriculture to services, as weak demand for agricultural products and a firm reliance on manufactured products and services distorted the allocation of more funds for the sector. Second, the output growth

needs to be increased to grab more investment funds for agricultural research, expansion and productivity enhancement, such as irrigation, storage, market access etc. This result is consistent with the studies on declining public funding for agricultural research (Pardey, Alston, & Chan-Kang, 2013; Byerlee, 2000).

Table 1: Coefficient Estimates of Model 1 (Dependent Variable: PBI)

Variables	*Coefficient*	*Std. Error*	*t-Statistic*	*Prob.*
LOG(AGDP(-4))	-0.298624	0.07825	-3.8165	0.0002
LOG(INF)	-10.15008	3.97746	-2.5519	0.0120
LOG(RPOPG(-3))	7.290912	3.75658	1.940837	0.0555
AR(1)	0.69426	0.09733	7.133082	0.0000
AR(2)	0.216081	0.09474	2.280903	0.0244
C	130.7787	49.5176	2.641057	0.0094*
R^2	**0.807898**			
Adjusted R^2 0.762				
Durbin-Watson stat 2.421				

Source: Estimated by Authors
Note: * shows significance at 10 per cent

The significant and indirect link of infrastructure could be related to the reorientation of public investments towards other development purposes, such as the rehabilitation of irrigation setups and the upgradation of water management and so on (Looney, 1999). Additionally, the rural population tend to show a positive effect showing that rural clusters with more population attract more investments in health, education and development.

4.1.2. Coefficient Estimates of Model2 (Private Investment)

The coefficient estimates of the model with the endogenous variable of private investment are presented in Table 2. The expected positive link between private and public investment has affirmed the inducement effect (Dhawan and Yadav, 1995). Despite the policy inconsistencies in the agriculture sector of Pakistan, public investment is a useful tool as it directly impacts private investment, ensuring crowding in effect. This has enlightened that a compatible public policy would tempt the private sector to invest in technological innovations while facilitating farm owners (Venkatesh, 2019).

The negative coefficient of agriculture productivity has disclosed that output growth is not a promising element to attract the private sector in Pakistan. It is convincing as private investors are more concerned about investing in agro-industries complementing farm output, while in the case of Pakistan, farmers

Table 2: Coefficient Estimates of Model 2 (Dependent Variable: PVI)

Variables	*Coefficient*	*Std. Error*	*t-Statistic*	*Prob.*
LOG(PBI(-5))	0.070621	0.04035	1.75002	0.0827*
LOG(AGDP(-4))	-0.298624	0.07825	-3.8165	0.0002
LOG(AGRM)	0.937393	0.30959	3.02788	0.0030
LOG(INF)	-10.15008	3.97746	-2.5519	0.0120
LOG(INSC)	0.573528	0.33772	1.69824	0.0922*
AR(1)	0.69426	0.09733	7.13308	0.0000
AR(2)	0.216081	0.09474	2.2809	0.0244
C	126.5309	48.4443	2.61188	0.0102
R-squared 0.922294				
Adjusted R-squared 0.892075				
Durbin-Watson stat. 2.017729				

Source: Estimated by Authors
Note: * shows significance at 10 per cent

are solely indispensable to invest in. This explains the incompatibility between the farmers and private investors (Syed & Miyazako, 2013). Conversely, the agri-mechanization assertively enhanced private investment in Pakistan. Hence, the private sector may fulfil virtuous and effective demand for machinery with its efficient supply chains (machinery and equipment) and services (Mrema, Kienzla, & Mpagalile, 2018). Besides, the negative association between infrastructure and private investment is justified by the argument of Looney (1999). The author highlighted that selective enhancements in the rural infrastructure facilities were not supposed to stimulate more capital from the private sector. Additionally, the model explicates that the contribution of institutional credit in increasing private investment is crucial to impact the farm income (Iqbal, Ahmad, & Abbas, 2003). On the whole, the performance of the private sector is well-defined through public sector efficiencies, mechanization advancements, and institutional credit.

4.1.3. Coefficient Estimates of Model 3 (Agriculture Output)

Table 3 explains the estimates of model 3 with agriculture output as an endogenous variable. The model's finding revealed solid and significant associations between public and private investments. This instigates the insight that the process of agricultural development counts on the synchronized progress of farm output, productivity and associated value chains, including an eclectic array of divergent (small- and large-scale) farm activities. According to Syed & Miyazako (2013), these activities further diverge towards input

availability, processing, storage, distribution, wholesaling and retailing, and exports (farm products). Collectively, this complete agricultural supply chain is referred to as **'agro-industry'.** Thus, there is an immense requirement to look at both investments keeping in view the target to transform the traditional agriculture sector into agro-industries. This outcome aligns with the study of Baba et al. (2010). Moreover, for estimation purposes, we have also taken the lag of the dependent variable in the model, as it is believed that agricultural productivity is significantly affected by its previous output efficiencies.

Table 3: Coefficient Estimates of Model 2 (Dependent Variable: AGDP)

Variables	*Coefficient*	*Std. Error*	*t-Statistic*	*Prob.*
LOG(PBI(-5))	0.070621	0.040354	1.750019	0.0827*
LOG(PVI(-2))	0.120825	0.066638	1.813139	0.0724*
LOG(AGDP(-4))	-0.298624	0.078246	-3.8165	0.0002
LOG(AGRM)	0.937393	0.309587	3.027883	0.0030
LOG(INF)	-10.15008	3.977461	-2.5519	0.0120
LOG(INSC)	0.573528	0.33772	1.698235	0.0922*
LOG(ISD)	0.712922	0.486906	1.464188	0.1458
LOG(NAS)	3.556884	3.006093	1.183225	0.2391
LOG(RPOPG(-3))	7.290912	3.756581	1.940837	0.0555
LOG(RAI(-2))	-8.535339	5.019472	-1.70045	0.0918*
AR(1)	0.69426	0.09733	7.133082	0.0000
AR(2)	0.216081	0.094735	2.280903	0.0244
C	159.3204	54.65225	2.915167	0.0043
R^2 0.960163				
Adjusted R^2 0.92339				
Durbin-Watson stat. 2.426264				

Source: Estimated by Authors Source: Estimated by Authors
Note: * shows significance at 10 per cent

The coefficient of agriculture mechanization is positive and significant, indicating its vital role in agricultural development (Raza & Siddiqui, 2014). According to Iqbal et al. (2015), agri-mechanization is a technological package enhancing productivity, field operations, and quality while reducing the annual losses of crops. Further, the concept of mechanization is still limited to the production of tractors due to selective agri- mechanization. The negative association of infrastructure development has provided evidence that lagging infrastructure developments may enhance production costs and consequently

slow agricultural output and investment (Looney, 1994). Turning to the role of institutions, the model has explained a positive link between the credit and productivity of the agriculture sector.

Over the years, extensions in institutional credit have facilitated a large segment of fam households, precisely small-scale farmers in Pakistan (Iqbal et al., 2003). The negative impact of rain could be associated with the rain uncertainties and damages caused by heavy rain in Pakistan. Consequently, this would tend to exert negative output growth in the farm sector (Baba et al., 2010). The positive association of the rural population demonstrates proverbial crowding in and attachment of more population with the sector. Besides, the net area sown and improved seed distribution coefficients is found insignificant in the model.

4.1.4. Coefficient Estimates of Model 4 (Agri-Mechanization)

As per the expected nexus in the conceptual model, the estimates in Table 4 have affirmed that agri-mechanization is significantly and positively affected by public and private investment at a 10 per cent significance level. Nevertheless, a promising agriculture output model entails the private sector's involvement to facilitate significant and medium-scale farmers that would further hide out small-scale households. Correspondingly, more support from the public sector is expected to complement and, meanwhile, create an environment for private-sector-driven mechanization (Kirui & von Braun, 2018).

Table 4: Coefficient Estimates of Model 4 (Dependent Variable: AGRM)

Variables	*Coefficient*	*Std. Error*	*t-Statistic*	*Prob.*
LOG(PBI(-5))	0.070621	0.04035	1.750019	0.0827*
LOG(PVI(-2))	0.120825	0.06664	1.813139	0.0724*
LOG(INF)	-10.15008	3.97746	-2.5519	0.0120
LOG(INSC)	0.573528	0.33772	1.698235	0.0922*
LOG(RPOPG(-3))	7.290912	3.75658	1.940837	0.0555
AR(1)	0.69426	0.09733	7.133082	0.0000
AR(2)	0.216081	0.09474	2.280903	0.0244
C	125.8703	49.0644	2.565408	0.0116
R^2 0.811617				
Adjusted R^2 0.738				
Durbin-Watson stat. 1.554				

Source: Estimated by Authors Source: Estimated by Authors
Note: * shows significance at 10 per cent

Meanwhile, infrastructure development had adversely affected the mechanization process, which must again be supported by the explanation provided by Looney (1994). In contrast, the availability of institutional credit has supported farm households to adopt mechanization. It has been presumed that credit from agricultural banks is essential to promote agricultural mechanization through structural advancement for irrigation with low costs, ultimately improving the land quality and rural economy (Marandi & Rashidpour, 2017). The direct association of the rural population with farm mechanization indicates the priorities of farmers for machinery that would pace the mechanization process. Hence, the estimates of Model 5 designate that strong credit support, and farmer's willingness would provide sustainability in the farm sector through mechanization (Luo & Escalante, 2015).

4.1.5. Coefficient Estimates of Model 5 (Farm Employment)

Given the fact that the farm sector provides employment to a big chunk of the population, the employment perspective has been indulged to relate this relevant variable with investment, productivity, infrastructure, institutional credit and population growth. The estimates of the final model are presented in Table 5, with farm employment as an endogenous variable.

Table 5: Coefficient Estimates of Model 5 (Dependent Variable: FEMP)

Variables	*Coefficient*	*Std. Error*	*t-Statistic*	*Prob.*
LOG(PBI(-5))	0.070621	0.04035	1.75002	0.0827*
LOG(PVI(-2))	0.120825	0.06664	1.81314	0.0724*
LOG(AGDP(-4))	-0.298624	0.07825	-3.8165	0.0002
LOG(INF)	-10.15008	3.97746	-2.5519	0.0120
LOG(INSC)	0.573528	0.33772	1.69824	0.0922*
LOG(RPOPG(-3))	7.290912	3.75658	1.94084	0.0555
AR(1)	0.69426	0.09733	7.13308	0.0000
AR(2)	0.216081	0.09474	2.2809	0.0244
C	123.7334	49.1056	2.51974	0.0131
R^2 0.747101				
Adjusted R^2 0.642966				
Durbin-Watson stat. 1.510732				

Source: Estimated by Authors Source: Estimated by Authors
Note: * shows significance at 10 per cent

The coefficients of both investments have revealed that it is an effective impetus to affect farm employment, indicating a positive spillover effect on

the farm labour market. This provides an intuition to expand the investment in order to accumulate human capital, ensuring a better quality of labour in the farm sector (Syed & Miyazako (2013)). Meanwhile, agriculture output and infrastructure development have indirectly affected farm employment. These findings jointly portray a remarkable transformation in employment in the rural economy of Pakistan. This is partly because uncertainties in the employment of the farm economy and infrastructure development have pushed workers out of the agricultural sector to move into non-farm sectors. This intuitively points out the pulling capacity of modern sectors to absorb the disguised employed and redundant/surplus workers of the farm sector (Behera & Tiwari, 2015; Gill & Ghuman, 2001). Contrary to these findings, institutional credit and rural population growth have unveiled a positive linkage with farm employment. Hence, financial strengthening through credit markets and human capital expansions are potential attributes for farm employment (well-paid) in the rural economy.

4.2. Capital Efficiency in Agriculture Sector

The ICOR and MEC have been estimated with intuition to dig out the efficiency of capital in the agriculture sector from 1981 to 2018. Given this, we have first calculated the ICOR and MEC for each year under consideration to trace the sector's efficiency pattern.

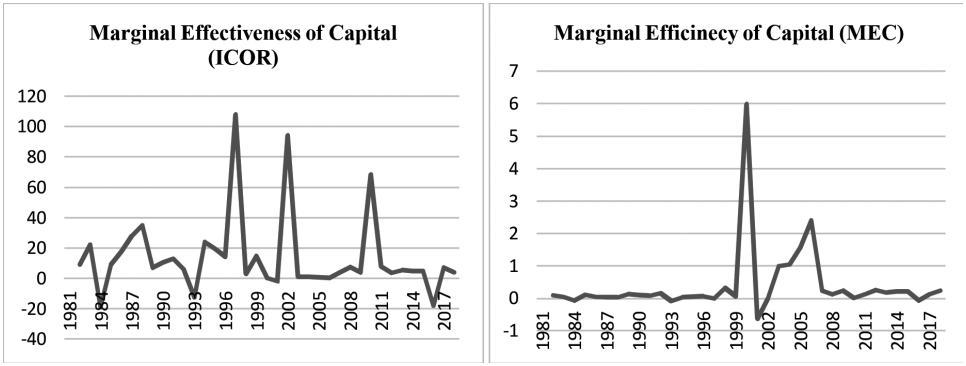

Figure 3: Capital Effectiveness and Efficiency in Agriculture Sector

Figure 3 portrays the trend in ICOR and MEC, showing irregular arrangements in the data over the years. The trend in ICOR displays divergences over the years, with maximum values of inefficiency in the 1990s and an increasing trend over the last few years. Overall, the marginal effectiveness of

the capital, i.e. ICOR, is very asymmetric. Further, the reciprocal of ICOR, i.e. MEC, exhibit relatively stable marginal efficiencies in initial years, reaching a maximum at the end of the 1990s and a consistent pattern over the last years. Besides, the calculated ICOR for different periods has disclosed notable outcomes over the spans for the farm sector in Table 6.

Table 6: Period-wise Capital Efficiency in Agriculture Sector (at 2005-06 prices)

Period	*Compound Growth Rate of Investment (r)*	*Compound Growth Rate of Output (g)*	*ICOR*
Period I (1981-85)	0.41	0.05	0.033
Period II (1986-90)	-0.15	0.06	0.10
Period III (1991-95)	0.21	0.06	0.09
Period IV (1996-00)	0.17	1.07	3.56
Period V (2001-05)	0.05	0.05	0.004
Period VI (2006-10)	0.06	0.03	0.01
Period VII (2011-15)	0.01	0.04	0.01
Period VIII (2016-18)	0.06	0.03	0.01

Source: Estimated by Authors

Through periods 1 to III, the capital investment in the sector experienced small values of ICOR, indicating an efficient utilization of capital in the sector. However, period IV experienced a positive yet considerable ICOR value, indicating relatively unproductive capital utilization (Kothe, 2013). Meanwhile, the sector regained its capital efficiency in later periods. Intuitively, capital efficiency in the agriculture sector is attributable to the increasing trend in private investment, while developing rural clusters through public investment expenditures is also effective.

5. PROSPECTS FOR CHANGE IN THE AGRICULTURE SECTOR OF PAKISTAN

The trend patterns of the investment, estimation findings of SEM and estimated capital efficiencies provide intuitions that understanding the

agricultural development process through investment is vital to accruing pre-determined growth patterns of the traditional economic models. Instinctively, the prospects of change for Pakistan's agrarian economy will be prescribed in lieu of the study's findings.

There is an emerging optimist view in development economics that a low growth share does not necessarily imply that the sector's performance is not impressive (Hussain, 2012). For instance, the economy of the United States (US) facilitates a bulk of the domestic and global population, using only 1.4 per cent of total labour in the agriculture sector in 2018 (World Bank Indicators, 2019). Further, in the contemporary era, agricultural development is predominantly considered a powerful tool to cope with poverty alleviation ensuring collective prosperity. According to the estimates of the International Bank for Reconstruction and Development (IBRD), the global development of the agriculture sector will be able to facilitate 9.7 billion individuals by 2050. It is also expected that the agriculture sector will experience a twofold growth raising incomes of the poorest than the other sectors, as 65 per cent of the poor population depend on the agriculture sector. (IBRD 2019). Hence, these insights suggest that the prevailing global food crisis and foreseen demand for food allow Pakistan to play its part effectively and grab its significant share in the international food market. This demands the serious attention of authorities to the development of the agriculture sector through providing sufficient investment infrastructure.

Referring to the investment prospects of the public sector, the government must focus on a good mix component of the investment function by giving attention to multi-faceted dimensions in order to attain desired targets. Mogues et al. (2012) argued that public spending on transportation and communication provides robust outcomes, while expenditures on education, irrigation, and R&D, in particular, demonstrate positive growth effects. Therefore, rather than protecting the agriculture sector, small-scale farmers must be empowered, and this could be achieved through revisiting the protection strategies, transparency and liability of prevailing policy initiatives under operation.

The role of the private sector in the development and change of the farm sector could be associated with exploring the heterogeneity of the sector. In this regard, private capital must be seen as a gamut of divergent elements that would range from small-scale farmers to large-scale producers. Further, women and young individuals must be inundated as the most relevant agents for change. The other private sector categories must be extended to agri-food and agri-business corporations.

Predominantly investments in mechanization rely on agricultural systems, land and productivity structures, opportunity costs of input, financial accessibility, comparative gain and expansion of markets and services (machinery) etc. Thus, mechanization and its related supply chains require a movement towards renewed policy imperatives. These may include analyses of the drivers of agri-mechanization, compatible arrangements of cooperative sharing and commercial leasing for farmers at both country and national levels (Morgues, Yu, Fan, & Mcbride, 2012).

Over the years, farm employment has experienced a significant diversion towards non-farm sectors despite facilitating a big chunk of the working population. This could destabilize the balance of the rural economy and thus stresses a well-coordinated employment initiative for the farm and non-farm sectors of the rural economy. Thus, farm employment must now be extended through knotting support programs for small-scale farmers and Small and Medium Enterprises (SMEs), complementing with training and technical support strategies for employment and income changes in the non-farm sector.

The agriculture setup in Pakistan now requires a transformation from traditional farming to agri-technology. Globally, the working patterns of farmers are changing as it requires new measures to extend the services of the farm sector. In this perspective, the idea of Information and Communication Technologies (ICTs) is valued in the development projects of rural masses. This emerging field helps to access related information that would enliven to apply better measures with much easier learning. ICTs are responsible for catering to short-term and long-term objectives. The former set of ideas can be utilized to change the mindset of traditional farmers by initiating learning and training programs to introduce them to modern farming techniques. This may tend to educate the farmers regarding land fertility and longevity testing and learning about the different land requirements for better productivity. The later set incorporates information related to data compilation, market, weather, price concessions, and diversification in profits from income (Chapman & Slaymaker, 2002). Further, mobile phones can be utilized to extend the supply at relatively low costs with high availability of information, as observed in Nigeria's local markets (Aker, 2010). This technology also serves the farmers to monitor persistent climate change over the years, as its high time for farmers in Pakistan to adopt knowledge-based farming rather than experience-based farming.

Hence, given the constraints and prospects, we have projected the following compact pro-poor initiatives that would reign the traditional economy of Pakistan.

The complementarity between the public and private sectors must be enhanced by promoting the growth of commercial agriculture throughout its value chains. In this regard, public policy must empower farmers and agro-industries to take the lead.

The sector's public policy must involve enabling and engaging farm owners for market expertise while persuading them to invest their savings in commercializing their farms.

The employment of farm and non-farm sectors must be put in place in feasible business plans for the rural economy. This would manage the exit of farm employment and absorption of non-farm employment.

6. CONCLUSION

The SEM perspective in the study provided an intuition that there is a dire need to develop a compact plan considering the agriculture sector's investment, productivity, mechanization and employment. The analysis also contributed to the existing literature favouring the complementarity hypothesis between the two divergent investments. This indicates that public investment can potentially augment private investment; meanwhile, it could attract more capital through compatible policy initiatives. Additionally, the study diagnosed a point of apprehension that appeared from the deviations in yearly ICOR and stagnant trend in annual MEC, showing the inconsistency of the capital attributed to various technical and transformational loopholes. However, the period-wise ICOR showed positive results over the years in capital efficiency. In this regard, instead of relying on protection policies for the sector, a technology-based perspective is highly required, which is only possible to attain with sufficient policy imperatives to enhance the investment. Hence, it is concluded that GoP has to ensure the functionality of the existing capital while injecting new capital into the sector to achieve productivity and growth targets. In this regard, the declining trend of public investment needs to be reversed. Meanwhile, agri-mechanisation must be accelerated through technological development and its spillover to other sub-sectors of agriculture.

Further, public-private complementarity in the sector would foster the process of rural development in compliance with the improvement in social

heads through creating more employment and better wages to create a "win-win" strategy in the sector and economy as well. Virtually, the prospects of change have been prescribed in the context of agricultural advancement in Pakistan, which has the potential to turn the historical patterns into unprecedented growth of the economy. This would, in turn, embraces better life expectancy rates and low risk of malnutrition, ensuring more investments in education, technology, mechanization and non-agricultural accomplishments. In a nutshell, a consistency between agricultural development and prospects for change through an investment perspective embraces the reliance of the sector on intensive rather than extensive policy measures.

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APPENDIX

Table A1: Description of Variables

Variables	*Abbreviations*	*Proxy*	*Unit of Measurement*	*Data Source*
Public Investment	PBI	Gross fixed capital formation in agriculture	Rs. Million	Handbook of Statistics &Pakistan Bureau of Statistics
Private Investment	PVI	Gross fixed capital formation in agriculture	Rs. Million	Handbook of Statistics &Pakistan Bureau of Statistics
Agriculture GDP	AGDP	Gross domestic product of agriculture	Rs Million	Handbook of Statistics & Pakistan Economic Survey 2018-19
Agri-Mechanization	AGRA	Tractor Production	Numbers	Pakistan Bureau of Statistics
Farm Employment	FEMP	Labour force participation in the farm sector	Percentage	Handbook of Statistics & Pakistan Economic Survey 2018-19
Rural Population	RPOP	Growth Rate of population in rural areas	Percentage	World Bank Indicators
Infrastructure	INF	Length of Roads (High type)	Km	Handbook of Statistics & Pakistan Economic Survey 2018-19
Institutional Credit	INSC	_____	Rs. Million	Pakistan Bureau of Statistics
Rain	RAI	Water Availability	Million Acre Feet	Pakistan Bureau of Statistics
Improved Seeds Distribution	ISD	_____	000 Tons	Pakistan Bureau of Statistics
Net Area Sown	NAS	_____	Million Hectare	Pakistan Bureau of Statistics

Source: Tabulated by Authors

Table A2: System Residual Portmanteau Tests for Autocorrelations

Lags	*Q-Stat*	*Prob.*	*Adj Q-Stat*	*Prob.*	*df*
1	27.34029	0.3391	28.47947	0.2863	25
2	50.90669	0.4377	54.09512	0.3209	50
3	68.85107	0.6778	74.48646	0.4950	75
4	90.76551	0.7346	100.5751	0.4650	100
5	111.4520	0.8016	126.4332	0.4473	125
6	131.4578	0.8598	152.7566	0.4221	150
7	148.3100	0.9293	176.1625	0.4611	175
8	172.4697	0.9210	211.6914	0.2720	200
9	188.3778	0.9639	236.5477	0.2855	225
10	203.7813	0.9854	262.2203	0.2852	250
11	214.6718	0.9971	281.6677	0.3781	275
12	225.2400	0.9996	301.9912	0.4569	300

Source: Estimated by Authors