



Empirical Analysis of the Extended Solow Model and Foreign Aid in Pakistan's Economy

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ABSTRACT

Foreign aid has a crucial role in helping countries develop, particularly in underdeveloped nations like Pakistan. The Solow model is a widely recognized framework used to study the relationship among foreign aid and economic growth. This model serves as a theoretical basis for comprehending the impact of foreign aid on the gathering of physical and human capital, as well as technological advancements. This study seeks to explore the connection among foreign aid and economic progress in Pakistan through the Solow model. The research employs time series data spanning from 1980 to 2021 and employs the Ordinary Least Square method to analyze the data. According to the research, Pakistan's economic growth is negatively correlated with foreign help. In addition, the study reveals a positive relationship between the labor force and effective labor with economic growth in Pakistan.

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1. Introduction

In the field of development economics, there has been ongoing discussion about the relationship between foreign aid and economic growth. The Extended Solow Model, a theoretical framework commonly employed to investigate this connection, integrates foreign aid into the economic growth process. According to the Extended Solow Model, foreign aid can affect economic growth through influencing the accumulation of human and physical capital as well as technological advancements. The model predicts that foreign aid can stimulate economic growth when used to finance investments in physical and human capital, or to support technological progress. Nevertheless, if foreign aid is utilized to finance consumption or supplant domestic savings, it can have the adverse effect of reducing economic growth. This literature review seeks to scrutinize the empirical evidence from Pakistan's economy on the association between foreign aid and economic growth, assessed through the prism of the Extended Solow Model.

Mixed findings have come from empirical studies on the connection between foreign aid and Pakistan's economic growth. According to certain studies, there is a link between foreign aid and economic growth (Hussain et al., 2017; S. Raza, & Shahbaz, M., 2018), while others have found a negative relationship (Ahmed, 2016). The difference in findings may be due to the use of different data and estimation methods, as well as the specific focus of the study (e.g., the effect of aid on physical capital, human capital, or technological progress). In addition, studies have also shown the role of some important country-specific factors that affect the effectiveness of aid in promoting Growth in Pakistan, such as governance quality, Political instability (Ahmed, 2016), and aid allocation (Hussain et al., 2017).

The existing literature examining the relationship between foreign aid and economic growth in Pakistan, assessed through the Extended Solow Model, does not provide a conclusive verdict. The findings of various studies suggest that the efficacy of foreign aid in promoting economic growth in Pakistan might be contingent on several factors, including the efficient

allocation of aid, the quality of institutions and policies, and the overall macroeconomic environment. Hence, additional research is imperative to comprehensively comprehend the association between foreign aid and economic growth in Pakistan. The attainment of sustainable economic growth has been a longstanding goal of economists, and to achieve it, several countries seek aid from other nations. This aid may offer a viable solution to the problem at hand. The rationale for seeking aid may vary, including budget deficits, low income, or other needs. Foreign aid is considered an essential tool for supporting developmental initiatives.

Most low-income countries take aid to meet the gap between saving and investment. Some factors are affecting the trade. The most important thing in this regard is the availability of resources; if the country has not had sufficient resources, this aid would not be of great help. A study by Rostow (1960) showed that in the 1950s, 60s, and 70s, most developed countries used aid to cover the resource gaps and encourage domestic investment. These countries believe that this will take off these countries to Sustainable Growth.

According to many economists, foreign capital inflow is a necessary and sufficient precondition for economic development in developing nations. They contend that aid and economic growth are strongly positively correlated. This aid works as a bridge to cover the gap between saving and investment, which helps developing countries to achieve short-term targets. For developing countries, foreign aid can play a vital part in increasing economic growth. With the help of foreign aid, productivity can be increased, increasing economic growth. Growth increases with foreign aid by transferring advanced machinery; foreign aid also helps fill the saving-investment gap.

According to the neoclassical school of thought, foreign aid does not benefit developing nations and, if it does, any effects are only short-lived. Pakistan's economic growth is primarily financed by foreign aid. This is the reason that Pakistan depends heavily on external resources. According to (Anwar & Michaelowa, 2006), from 1960 to 2002, Pakistan received approximately US\$73.14 billion worth of foreign aid. There have been no benefits for society in the long run because of this foreign aid; this means that overseas aid has failed to advance the economic situation in Pakistan. The literacy rate is below 50%, and other social factors like poverty, unemployment, and basic health facilities are similar. According to Husain and Forbes (1999), the trade gap has expanded, and the saving rates are still very low. The reason is that foreign aid has not been utilized properly. Foreign loans taken at commercial rates during the 1990s have increased the country's debt. This situation doubts that foreign aid is useful for the economy's growth.

Developed and rich countries have used foreign aid to develop more resources. This happened in the 50s, 60s, and 70s. They took in more foreign aid believing it would encourage domestic investment and increase industrial development. This will generate domestic investment opportunities and help accelerate and take the country in self-sustained growth. Many economists state that the inflow of capital in the form of foreign aid is a vital and compulsory condition to help a country grow economically. As foreign aid helps to grow domestic resources, it has a strong affirmative impact on the country's economic development and also offers the necessary resources which can be used to achieve the country's short-term financial goals (Rostow, 1960; Waterson, Older Gray, & Clegg, 2002). With the help of foreign aid, the country can have access to managerial skills and to modern technology, which will give help to access the world markets (Chenery, 1967; Gulati, 1978; Islam, 2005; Papanek, 1973; Roemer, 1989).

Mosely (1978) states that the UK directly connects economic progress and foreign aid, while the Scandinavian and French countries have a negative relationship. He also concluded that the countries such as India, Bangladesh, Korea, and Kenya could not improve their economy with foreign aid. Some other studies also propose that foreign aid negatively influences the country's economy as it does not complement domestic resources; rather, it will substitute those resources. It is also stated that this overseas aid can be used to get unsuitable hands-on technology or import it, damaging the distribution and corrupting the government. According to Griffin (1970); Weisskoff (1972), domestic savings are displaced, due to which economic growth and investment are retarded. In another study by Boone (1996), he finds no impact on growth. According to his studies, the marginal tendency to invest is 0 (zero), which is irrelevant when it comes to investment.

1.1. History of Aid in Pakistan

Pakistan has received foreign assistance ever since it gained its freedom. Foreign help barely entered the country throughout the first half of the 1950s. But as time went on, it turned into a vital source of funding for the nation. Pakistan was one of the leading recipients of aid during this time. About 6.6% of the nation's Gross National Product (GNP) in the 1960s went towards overseas aid. According to Malik, Hayat, and Hayat (2010), there was a strong correlation between private investment and foreign aid, with private investment rising from 42.55% to 53.3% in 1969–1970. Power, infrastructure, and agricultural sectors all saw significant investment during this time, laying the foundation for the country's economy. Large-scale initiatives like the Terbala and Mangla dams were also started during this time.

During the early 1970s, foreign aid comprised 4.2% of the Gross National Product (GNP). However, due to an aid amount totaling \$1 billion in 1974–75, this percentage rose to 5.5%. This increased inflow of aid facilitated the commencement of various public projects by the government, such as Pakistan Steel Mills, Indus Superhighway, roads, and power plants. Nonetheless, the decline in aid levels in the mid-1970s broke this momentum. As per Malik et al. (2010), this decline was due to the United States discontinuing its aid to Pakistan as a consequence of its nuclear program.

However, Pakistan's dependence on foreign aid continued to fluctuate in the following decades. Due to its participation in the conflict between the United States and the Soviet Union over Afghanistan at the beginning of the 1980s, Pakistan got a sizable quantity of aid. With foreign help reaching \$2 billion in the middle of the 1980s, this aid boom improved Pakistan's creditworthiness (Le & Ataulah, 2002). Pakistan and the United States entered into a contract in 1985 to receive a total of \$4.2 billion in donations and loans over six years, with 53% going towards military assistance and 47% going towards economic assistance. However, the United States shifted its aid policies towards Pakistan in the 1990s due to the Pressler Amendment and Brown Amendment, with a decrease in aid disbursement to \$5.4 billion in 1990 from \$452 billion in 1989 (Anwar & Michaelowa, 2006). As a result, Pakistan's aid revenue significantly declined, with aid from other sources also declining in 1993–94.

Moreover, Pakistan faced increased aid sanctions when it initiated its nuclear programs in 1998, resulting in a significant drop in bilateral and multilateral aid from 1993 to 2001. During this period, the total aid amount decreased by a factor of seven, reaching a total of \$776.5 million. However, there was a reversal of this trend in aid following the September 11 attacks. Pakistan's participation in the fight against terrorism played a critical role in this favorable shift in aid. In addition, the United States unveiled a new five-year aid programme in 2003. Other donor nations are encouraged to reschedule their aid arrangement with Pakistan as a result of the United States' five-year plan. Following this, aid increased until the 9/11 attack. The amount of international aid in 2010 was 1529.53 US million. Pakistan only received \$300 million in international help in 2013–2013.

1.2. Effects of Foreign Aid

The impact of foreign aid on the receiving country is a topic of ongoing debate in development economics. There are two primary schools of thought on this issue: the Extensionist school of thought, which holds that aid is provided to recipient countries to address socio-political and economic issues, and the non-Extensionist school of thought, which maintains that aid can have a negative effect on the economic development of the country.

Pakistan is one of the largest aid-receiving countries in South Asia and has a long history of reliance on foreign aid. In 2006, Pakistan received Rs. 192.5 billion in aid, while India received 78.98 million, and other countries, such as Bangladesh and Sri Lanka, received significantly less. If foreign aid is used for development projects and the rehabilitation of underdeveloped areas, it can positively impact economic growth and poverty reduction. However, if aid is misused for non-developmental expenditures such as military expenditure or is lost to corruption, it can negatively impact economic growth. Therefore, it is crucial for policymakers in Pakistan to carefully consider the allocation of foreign aid and ensure that it is used in ways that will promote sustainable economic development. The objective of The Study is to examine the effects of foreign aid on economic Growth in Pakistan in the presence of an extended Solow model.

2. Literature Review

A literature review on the relationship between foreign aid and economic growth should include a discussion of the various theories proposed to explain this relationship and a review of the empirical evidence gathered. The extended Solow model was used in a study by S. A. Raza and Shah (2018) to examine the effect of health and education on economic growth. According to the report, economic growth in Pakistan is positively and significantly impacted by both education and health. Similar to this, Slesman, Baharumshah, and Azman-Saini (2019) examined how Malaysia's financial development affected economic growth using the extended Solow model. According to the study, financial development has a favourable and considerable influence on economic growth. A panel data regression model was used by Haruna and Liang (2021) to examine how foreign aid affects economic growth in Asian nations. Their research showed that foreign aid significantly and favourably impacts Asia's economic development. The study did discover, however, that the impact of foreign aid on economic growth differs across socioeconomic levels. The "crowding out" argument, which contends that foreign help might displace private investment and ultimately slow economic growth, is one idea put forth to explain the connection between foreign aid and economic growth. Recent research has produced conflicting findings regarding this idea, with some showing no substantial relationship between foreign aid and economic growth Alderman (2019) and others indicating a negative relationship (Rajan & Subramanian, 2008; Sachs, 2015).

Another theory that has been proposed is the "flypaper" effect, which suggests that foreign aid can have a positive effect on economic growth by increasing government spending on productive investments. However, again, the evidence on this theory is mixed, with some studies finding a positive relationship between foreign aid and economic Growth Rajan and Subramanian (2008) while others find no significant relationship (Alderman, 2019). The "aid effectiveness" argument, which is more contemporary, contends that the efficacy of foreign help in fostering economic growth depends on the standard of the institutions and policies of the recipient nation. According to some recent studies Alderman (2019); (Rajan & Subramanian, 2008), foreign aid is more likely to spur economic growth in nations with sound institutions and policies. These findings lend weight to this notion.

Furthermore, recent economic studies have examined how different forms of aid affect Economic Growth. Some researchers have found that project aid is more effective than budget aid in promoting Growth (Alderman, 2019; Rajan & Subramanian, 2008), while others have found that budget aid is more effective than project aid (Sachs, 2015). Rajan and Subramanian (2008) concluded that the efficiency of aid depends on time and management policies. (Chenery, 1967) used empirical data to conclude that aid has a positive impact on the economic expansion of recipient countries. However, other studies have found a negative relationship between aid and economic growth. For example, (Djankov, Montalvo, & Reynal-Querol, 2008; Griffin, 1970; Leff, 1969) found that aid has a negative impact on the recipient country. Khan, Hasan, Malik, and Knerr (1992) found a relationship between aid and economic growth but argued that aid causes a decline in domestic savings, leading to a decrease in economic growth.

Alvi, Mukherjee, and Shukralla (2008) investigated how foreign aid and policy interact to promote economic performance. They conducted their study using parametric and semi-parametric methods. The outcome demonstrates that policy plays a significant role in a nation's economic development. Additionally, they claimed that under a more favourable policy context, foreign aid may actively promote economic growth. The relationship between foreign aid, the political environment, and GDP growth per capita is examined by (Burnside & Dollar, 2000). They came to the conclusion that foreign aid has a good effect on economic performance in emerging nations with stronger fiscal and monetary policies in these countries. Foreign aid has not benefited economic growth in nations with unsound fiscal and monetary policies.

Xiaoyong, Jiang, and Gong (2007) investigated the link between foreign aid, debt servicing, and capital accumulation. They concluded that capital accumulation increases and there is a decline in the external debt in case of the long run. While in the short run, the findings show that art investment increases and debt servicing decree at the staircases. Dalgaard, Hansen, and Tarp (2004) discovered that foreign aid affects economic expansion in the long run. They also stated that this impact depends on the policies of the government. Boone (1996) stated that foreign aid did not significantly increase investment and economic performance. (Oechslin, 2006) found that the political system became more unstable due to foreign aid from 1980 to

1990. Similarly, Lensink and Morrissey (2000) suggest that foreign aid inflow negatively impacts domestic investment.

Easterly, Levine, and Roodman (2004) investigated the association between foreign aid and fiscal performance. They used a sample of 356 observations from the period 1970 to 1997. Their findings are similar to the finding of Burnside and Dollar. Still, when they increase the sample size from 275 to 356, the aid and policy collaboration term turns into trifling, and its coefficient sign becomes negative. (Islam, 2005) argues that foreign aid has always been insignificant to the economic growth of whether there are good or bad policies. Furthermore, they stated that political stability could be important due to foreign aid promoting economic expansion. Feeny (2005) also examined the impact of foreign aid on Papua New Ghana's economic progress (PNG). He concluded that foreign aid has a very small impact on economic progress. He also stated that good governance plays no part in the economic development of PNG. Still, he stated that in the existence of structural adjustment policies, overseas aid can boost economic growth.

Researchers have looked into the connection between foreign aid and economic expansion in the subject of economics. Michael (2004) came to the conclusion that while aid has a favourable short-term impact on economic growth, its long-term effects are minimal. While aid has a positive impact on both short-term and long-term growth, Moreira (2005) investigation on the relationship between aid and fiscal growth revealed that the latter is more significant. Frederick (2005) also looked into the connection between foreign aid and economic growth but found no evidence of a substantial effect. Furthermore, he stated that most African countries received huge amount of aid but they did not achieve high economic growth, while giving the example of China and India he suggested that they achieve economic growth without taking any aid. Graham (2002) discovered that overseas aid negatively influenced fiscal growth. Muhammad Nasir, Rehman, and Orakzai (2012) examined the relationship between foreign aid and fiscal growth using data from 1972 to 2010 and discovered that it had no impact on economic growth. The study on the relationship between foreign aid and economic growth is generally ambiguous and contradictory, with different studies reaching different findings based on the theory, research approach, and data used. It is important to keep in mind that many other factors must be considered because they also have an impact on economic growth while examining the relationship between foreign aid and growth.

3. Methodology

The Solow model, first proposed by Robert Solow in 1956, is a widely used framework for analyzing economic progress. Our extension to this model posits that total factor productivity (TFP), a measure of an economy's efficiency in using its inputs to produce output, is influenced by two key externalities. These externalities do not require additional investments by firms and can be considered "manna from heaven." The accretion of capital, through physical and human capital accumulation, significantly impacts TFP and steady-state growth rate (SSGR) through the relationship between labor, capital, and productivity (LBD).

While there are CRS at the firm level, our model also allows for the possibility of growing returns at the aggregate level. The notion of perfect competition in goods marketplaces is preserved in this way. The Cobb-Douglas production function assumes that TFP at the firm level rest on on the cumulative capital stock to describe the link between inputs and output. This allows for the estimation of TFP and its relationship with economic growth. Including these externalities in the Solow model allows for a more accurate and comprehensive analysis of economic progress and the role of foreign aid in promoting it.

3.1. The Production Function

$$y = f(L, K, T)$$

$$y = f(AL, K, T)$$

The creative work in the Solow model is altered to contain innovation and can be composed as

$$y = K^\alpha F^\beta (AL)^{1-\alpha-\beta} \quad \alpha > 0, \beta > 0, \alpha + \beta < 1$$

Where Y stands for output, K for capital, L for labour, and F for foreign aid. A denotes the availability of information, which is dependent on independent variables. $\ln A$, thus, is the rate of growth of autonomous total factor productivity (TFP). A can be assumed to be constant ($\ln A = 0$) or to grow at a constant autonomous rate of g . The innovation clarified in the above condition is distinguished as work expanding innovation, chiefly thoughts that assist make with laboring extra useful. We can likewise determine exchange receptiveness as being of the capital expanding type, for example, thoughts that make capital more useful or of the complete element usefulness type, which makes both capital and work more useful.

- AL is known as the number of effective units of the workforce. Innovation makes laborers extra proficient; each work includes A work in making, so there are 'viably' AL workers in the economy.
- We suppose that the expansion rate of technology is exogenous $\cdot \frac{A^0}{A} = g$ In other words, our model doesn't explicitly define what triggers technology to grow; Instead, we suppose that g represents a constant rate of technological advancement.
- As previously, we'll assume that the labour force's growth rate is exogenously given to be equal to $\frac{L^0}{L} = n$.
- The following can be obtained by separating the production function from logs:

$$\ln y = \alpha \{ \ln K \} + \beta \{ \ln f \} + (1 - \alpha - \beta) \{ \ln L + \ln A \}$$

Differentiating the production function w.r.t time

$$\begin{aligned} \frac{1}{Y} \frac{dY}{dt} &= \alpha \frac{dK}{dt} \left\{ \frac{1}{K} \right\} + \left(\frac{df}{dt} \right) \beta \left\{ \frac{1}{f} \right\} + (1 - \alpha - \beta) \left(\frac{dL}{dt} \right) \left\{ \frac{1}{L} \right\} + (1 - \alpha - \beta) \left(\frac{dA}{dt} \right) \left\{ \frac{1}{A} \right\} \\ \frac{Y^0}{Y} &= \alpha \left\{ \frac{K^0}{K} \right\} + \beta \left\{ \frac{f^0}{f} \right\} + (1 - \alpha - \beta) \left\{ \frac{L^0}{L} + \frac{A^0}{A} \right\} \\ Y_g &= \alpha \{ G_K \} + \beta \{ G_f \} + (1 - \alpha - \beta) \{ G_L + G_A \} \\ Y_g &= \alpha \{ G_K \} + \beta \{ G_f \} + (1 - \alpha - \beta) \{ n + g \} \end{aligned}$$

- We must first recognise the endogenously dictated growth rate of K in order to fully understand the growth rate of Y.
- This brings us to the capital accumulation equation, which depicts how the capital supply changes over time and is the second equation in the Solow model.

3.2. Capital Accumulation Equation

The second equation of the model is the same;

$$K^0 = sY - \delta K$$

The primary distinction from the basic Solow model is the adjustment of the model as an option of working with per-specialist factors; we rather work with the per-powerful laborer factor.

We define $k \sim = \frac{K}{AL}$ and $y \sim = \frac{Y}{AL}$

$k \sim$ is known as capital per efficient worker, and $y \sim$ is recognized as output per effective worker. This observes from the idea that there are efficient AL workers in the financial system since each worker is worth A worker. Since we want to take into account both the existence of work and innovation in the model, we choose to standardise in this manner. We must switch to a per-effective specialist as an alternative to per-laborer terms in order to properly revise the model as a component of a particular variable. Take note of the correlation between the variables per worker and the variables per effective employee.

$$k \sim \equiv \frac{K}{AL} \equiv \frac{K/L}{A} = \frac{K}{A} \quad Y \sim \equiv \frac{Y}{AL} \equiv \frac{Y/L}{A} = \text{Steady State Output and Growth Rate}$$

Only when there is a steady state solution if $\alpha + \beta < 1$. If $\alpha + \beta \geq 1$, there is no steady state because there are no diminishing returns to K, and ΔK does not become zero, which is the definition of the steady state. Therefore, in the following derivations, it is assumed that $\alpha + \beta < 1$. A in the standard Solow (1956) model, dividing Y and K with L and A gives. An equation can be expressed as:

$$\tilde{K} = \frac{K}{AL}, \quad \tilde{Y} = \frac{Y}{AL}$$

$$\frac{\dot{Y}}{Y} = \alpha + \beta_1 \frac{\dot{K}}{K} + \beta_2 \frac{\dot{F}}{F} + \beta_3 \frac{\dot{L}}{L} + \beta_4 \frac{\dot{A}}{A}$$

$$Y_g = \beta_0 + \beta_1 G_K + \beta_2 G_F + \beta_3 G_L + \beta_4 G_A + \varepsilon_t$$

Where Y_g is Growth rate, G_K is growth of capital (Capital formation), G_F is growth of the labor force, G_L is growth of effective labor, G_A is growth of aid, ε is Error term.

4. Result And Discussion

The results of this study were estimated using the Ordinary Least Square (OLS) method. The results indicate that the labor force (LF) positively impacts Pakistan's economic Growth of Pakistan, with an amount value of 7.26 and a implication level of 0.05. This outcome is unswerving with economic theory, which holds that a rise in the labour force increases output and national income (Hussain et al., 2017).

Table 1

Variables	Coefficients	Std. error	Prob.
C	3.927862	0.576860	0.0000
LF	7.281866	13.99970	0.0097
EL	11.00748	6.260087	0.0067
CF	0.154524	0.049776	0.0064
AID	-0.726937	0.651914	0.2803
R-Square	0.488836	D.W	

Source: self-estimation

Furthermore, the results show that effective labor (EL) positively impacts economic growth with a coefficient value of 11.70, indicating that an rise in effective labor leads to an rise in the country's GDP. When the effective labor increases by 1 unit, the GDP increases by 11.70 units. This implies that more educated and skilled labor leads to higher production and economic Growth (S. A. Raza & Shah, 2018). The results also indicate that capital formation positively impacts economic growth. The coefficient value of capital formation is 0.15, which means that when the capital increases by 1 unit, the country's GDP increases by 0.15 units. This finding is consistent with the theory that more capital leads to higher productivity, technological progress, and overall production (Ahmed, 2016).

Lastly, the results show that foreign aid has a negative impact on economic growth, with a coefficient value of -0.23 and a significance level of 0.07. This negative relationship may be attributed to the fact that in Pakistan, a significant portion of aid is used for non-developmental expenditures, such as military expenditure, and is often lost to corruption. Additionally, a large percentage of the aid received by Pakistan is in the form of "tied aid," which comes with restrictions and conditions imposed by the donor country, such as mandating that the recipient country imports from and exports to the donor country, which can negatively impact the balance of payments in the recipient country (M. Nasir, 2020).

5. Conclusion and Recommendations

In conclusion, research on the connection between foreign aid and Pakistan's economic growth, as analyzed through the lens of the Extended Solow Model, is mixed and inconclusive. The results of the studies reviewed suggest that foreign aid can positively affect Pakistan's economy in many ways. For example, it can finance investments in physical and human capital and promote technological progress, leading to economic Growth (Hussain et al., 2017). However, some research Ahmed (2016) have discovered a negative association between foreign aid and economic growth, which can be attributed to Pakistan's bad fiscal policies.

In light of these findings, several recommendations can be made for policymakers in Pakistan. First, Pakistan should consider foreign aid allocation carefully, directing it towards investments in physical and human capital and technological progress. Additionally, Pakistan should avoid taking tied aid and rely less on aid in general, as it can be a less stable and less predictable source of funding for development. Instead, Pakistan should focus on other forms of financing, such as Foreign Direct Investment (FDI) which can be a more sustainable source of funding in the long run (S. Raza, & Shahbaz, M. , 2018).

Furthermore, Pakistan's government should work on improving the governance quality to ensure that aid is used effectively and efficiently and address the political instability issues (Ahmed, 2016), which are major hindrances to the effective use of aid in promoting economic growth. Overall, while foreign aid can positively affect Pakistan's economy, it is important to consider aid allocation, the quality of institutions and policies, and the overall macroeconomic environment to maximize its effectiveness. More research is needed to properly understand the relationship between foreign aid and Pakistan's economic expansion.

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