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Food Insecurity, Population Growth, Urbanization and Water Availability: The Role of Government Stability

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Abstract: To examine the impact of population growth, urbanization and water availability on food insecurity, this study utilized time series data for the period of 1990–2019, from World Development Indicators (WDI), Food and Agriculture Organization (FAO), and World Bank. The study applied an Auto-regressive distributive lag (ARDL) co-integration approach to test the hypothesized relationships among modeled variables. The study found a negative and significant association of water resources and agriculture research with food insecurity while urbanization and population growth has a significant and positive impact on food insecurity in the short-run as well as in the long-run period. Moreover, the study found that political stability has a negative and significant association with food insecurity in the short-run and long-run periods. Results also indicated that political stability significantly strengthens the relationship of water resources, and agriculture research with food insecurity while political stability weakens the relationship of urbanization and food insecurity significantly.

Keywords: food insecurity; population growth; water resources; agriculture research; political stability

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1. Introduction

More than 850 million people are chronically hungry; almost one in seven people around the world don't have enough food to live a healthy and active life. Moreover, the percentage of undernourished people also persistently increasing since 2014 [1]. According to Food and Agriculture Organization of the UN, the number of malnourished people in the world reached approximately 834 million in 2017 [2]. Therefore, food insecurity became a crucial issue that needs to be solved as it becomes a substantial risk in the achievement of sustainable development goals (SDGs) and leads to many economic and non-economic problems [3]. Food insecurity indicates the limited supply of adequate food in a household, or the inability of a household to obtain quality foodstuffs in a socially acceptable way [4]. For instance, food insecurity and low nutritional quality food cause mental and physical development impairments among adults [5], various infectious diseases [6], and unacceptably high numbers of premature deaths [7]. No doubt food inflation and economic prosperity greatly affect food insecurity, but socio-economic trends like population growth, urbanization, water resources, and agriculture scientific research also play an important role that needs to be investigated to provide an efficient solution to remove food insecurity.

The population is among one of the most crucial factors which increase the level of food insecurity [8]. Producing sufficient food for a growing population has always been a challenge because emergent population imposes pressures on the agricultural sector [9], and the rate of urbanization also increases and people start using the land for urban development instead of agriculture production, and thus the level of food insecurity increases [10].

Urbanization is another important factor that leads to food insecurity [11]. Rapid urbanization reduces the agriculture production via the decline in the quantity of arable land and the departure of labor [12], and result in the loss of potential crop yield due to the transformation of productive land to its non-productive usage. The non-productive usage of arable land reduces its soil quality and leads to food insecurity [13].

Water shortage is also a significant driver of food insecurity [14]. Water is an essential requirement for agriculture production. For instance, without enough supply of water farmers are unable to irrigate their agricultural land which adversely affects their crop yield and agriculture production [15]. However, Pahl-Wostl [16] postulates that water is not only a requirement for agriculture production, rather it is a primary source of cooking and food processing; so the shortage of water increases food insecurity. According to the findings of Kirby, Bartram [17], 15% of the world population is undernourished due to the uneven supply of water for household food processing. The unavailability or inadequate supply of water is, therefore, considered as a barrier to the achievement of food security.

Lack of research and development is another factor that causes food insecurity. It is believed that the unavailability of appropriate agriculture machinery and the dependency of farmers on conventional methods is the main barrier in agriculture production growth. Undoubtedly, the demand for food continues to grow with the rapid increase in population and urbanization. This increased demand for food necessitates increased agriculture production that is possible by utilizing modern method of production [18]. Conceição, Levine [19] recognized a food gap of around 70% between the crop calories available in 2010 and expected calories to be in demand in 2050. The study suggested that the only possible way to fill this gap is adoption and adaptation of advanced technology by the farmers. Hence, the adoption of advanced technology (i.e., tractors, plant breeding machines, hybrid rice technology, etc.) by the farmers is essential agriculture productionto overcome the problem of food insecurity [20]. The adaptation of advanced technology is not possible without sufficient governmental funding in research and development (R&D) [21]. The present study, therefore considers that a stable government plays an important role to eliminate food insecurity. Moreover, a stable government not only provides the funding for R&D but also ensures the eradication of food insecurity through the provision of basic needs and the implementation of efficient policies.

1.1. Food Security and Sustainable Development Goals (SDGs)

Food security and SDGs are inseparable. Arguably, seven out of seventeen SGDs are purely related to “food and agriculture” (see Figure 1). For instance, SDG 2 i.e., “end hunger, achieve food security and improved nutrition and promote sustainable agriculture” is primarily focused on food. This goal is a forward commitment of *“ZERO HUNGER”* by the end of 2030, which is only possible by reducing food insecurity. SDG 1 emphasizes “poverty reduction”, that is related with eradication of food insecurity. The present study, therefore, considers that food insecurity is among one of the main challenges for the whole world. The study argues that agriculture production there are numerous barriers like rapid population growth and urbanization, and water scarcity that hindered in the way of achieving goal of food security. The only solution to eradicating these barriers is “policy support”, which is possible through the political stability. The present study, therefore, proposes that a stable government plays important role to overcome food shortage by making efficient policies for the eradication of the barriers in the way of food security.

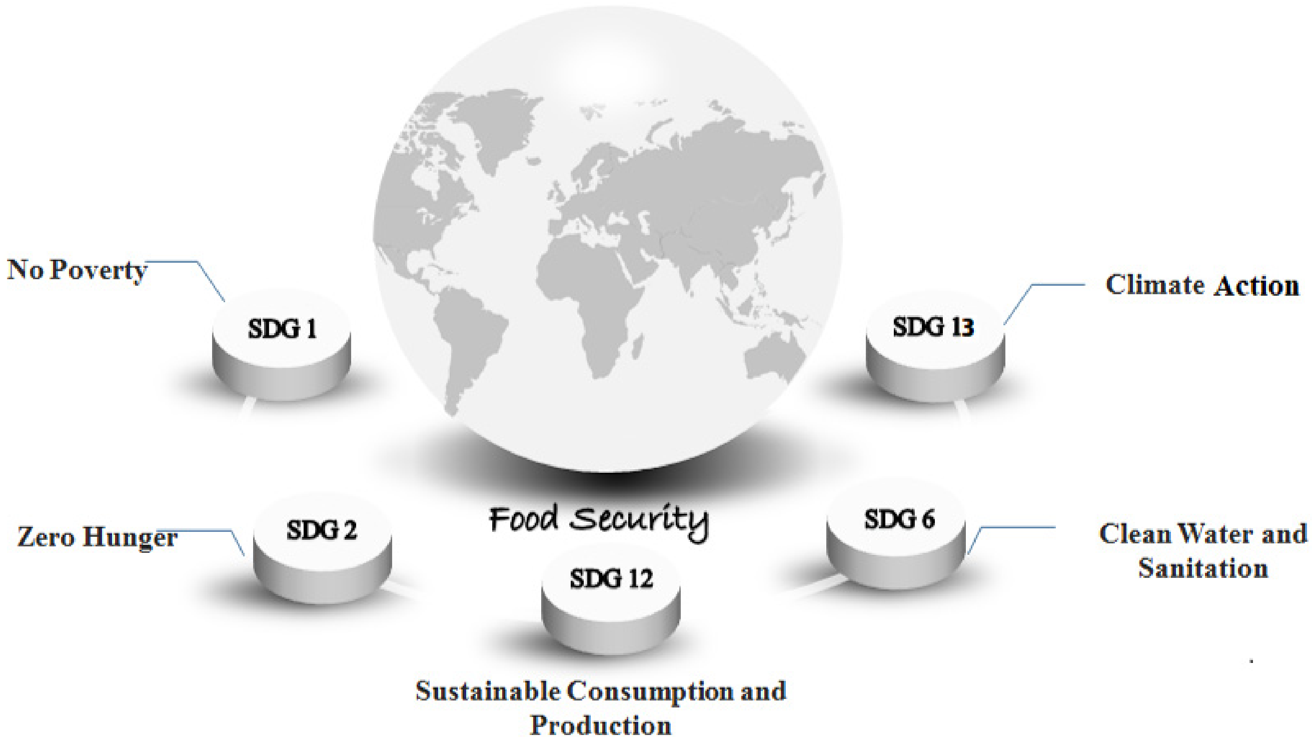

Figure 1. Food Security and Sustainable Development Goals; Source: Author generated.

1.2. Research Gap

The available literature on food insecurity highlighted numerous gaps and limitations that the present study intends to address. First, the study found that a nexus between water availability and food insecurity is a less focused area among the researchers, mostly this area remains under the theoretical discussion of researchers [22]. Second, the empirical studies on the relationship between R&D and food insecurity are lacking in the main literature a few studies [19,23] theoretically discussed this linkage. Third, the Resource base approach provides the clear theoretical lenses to expect a moderating role of government stability on the association between urbanization, population growth, water availability, R&D, and food insecurity. However, to the best of our knowledge, until now, the moderating role of governmental stability on the association among the selected variables is a neglected aspect in the available literature of food insecurity, specifically in the context of developing economies, like Pakistan. The present study, therefore, attempts to contribute to the existing debate of food insecurity in the following two ways: First, the study empirically investigates the role of urbanization, population growth, water availability, and R&D in food insecurity. Second, the study tests the moderating role of governmental stability on the relationship between the study variables.

1.3. Why Did Researchers Conduct This Study on Pakistan?

This study has been conducted in the context of Pakistan for several reasons (shown in Figure 2); first, Pakistan is a "lower-middle-income country", and ranks number six based on its population. However, more than 30% of Pakistan's population is malnourished and approximately 46% of the children under the age of 7 are inhibited (WFP, 2020). Three out of five households (i.e., around 61%) are within the lowest two income quintiles of household integrated economic survey (HIES) and are experiencing severe food insecurity (HIES, 2019). Second, Pakistan is facing rapid urbanization; for instance, 36.92% of its total population lives in urban areas, with a 12% prevalence of food insecurity (World Bank, 2018). Third, currently, 1.3 billion Pakistani residents do not have the access to clean water; and the shortage of water imposing adverse effects on the health of the country's residence and creating a barrier in the production of food or agriculture production which results in severe food insecurity. Fourth, a large number of farmers are strict with the traditional method of cultivation and are hesitant to adopt the new method of production in the agriculture sector [24]. The dependency of farmers on their conservative or conventional methods results in a yield gap which leads to food insecurity [2]. Fifth, Pakistan has enough resources to satisfy basic human needs, but, unfortunately, the implementation of ineffective policies create food insecurity. Thus, there is a dire need to work on the socio-economic factors of food security in the context of Pakistan by incorporating the moderating role of governmental stability to provide efficient policies to achieve food security.

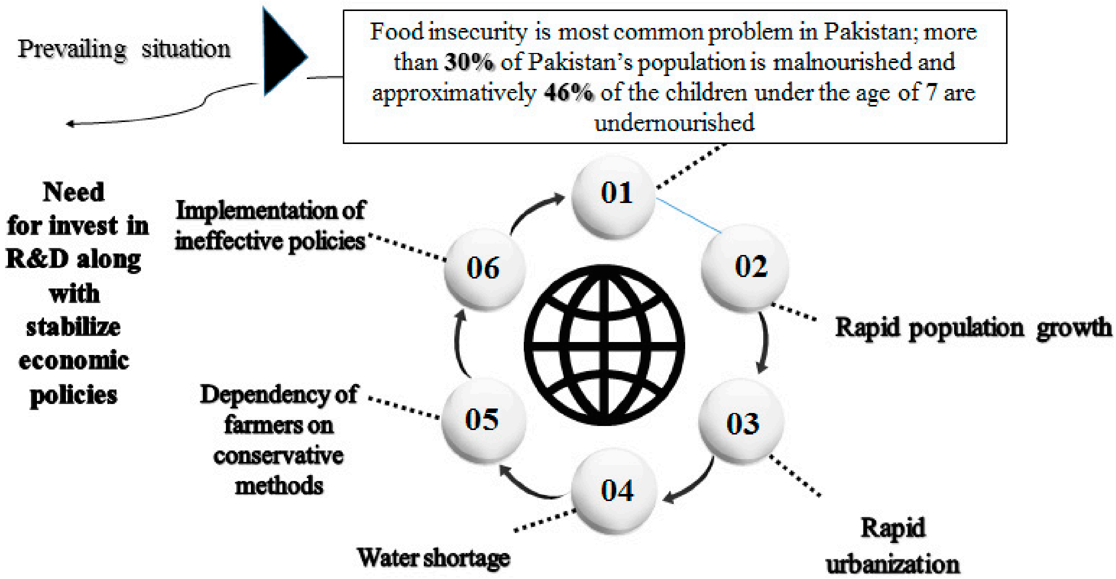

Figure 2. Reasons behind the conducting research on Pakistan; Source: Author generated.

At this crucial stage, when Pakistan is struggling to tackle the issue of malnutrition, undernourishment, starvation, and food insecurity. The results of the study do not only contribute to the literature but also helps the policymakers in making sound policies for the eradication of food insecurity that help the country to achieve the SDGs 2030 goals. Moreover, the study provides a new dimension to future researchers by incorporating government stability as a moderating factor in the study. Finally, the present study is an opportunity for future researchers to conduct a replica of this study in different developing and emerging economies.

2. Literature Review and Hypotheses Development

2.1. Food Insecurity and Urbanization

A nexus between urbanization and food insecurity is a highly debated area in the field of economics. Several researchers have investigated the impact of urbanization on food security and found a negative relationship between these variables. The studies concluded that urbanization tends to increase food insecurity. For instance, Chen [25] conducted his research in China and found a negative association between urbanization and food security. The author indicated that urbanization exaggerated the nation's rapid need for food security. Similarly, Matuschke [26] argued that urbanization adversely affects the production of grains. Liu, Xu [27] examined the empirical association between urbanization and food security found a negative relationship between urbanization and food security in china for the period of 1990–2010. The author found that due to rapid urbanization, agriculture production is declining at the rate of 7.24% annually in China. Hovhannisyan and Devadoss [13] showed a positive relationship between urbanization and food insecurity. The study concluded that rapid urbanization instigates the loss of agricultural land deteriorates the soil quality which thus leads to food insecurity. Shu and

Chen [28] also found a direct association between urbanization and food insecurity and argued that rapid urbanization is a barrier to the level of food security. Considering the above literature, the present study hypothesizes that:

Hypothesis 1 (H1). *There is a relationship between urbanization and food insecurity.*

2.2. Food Insecurity and Population

Numerous researchers have studied the relationship between population and food insecurity and indicated the positive association between these variables. For instance, Bremner [29] conducted their research on Africa to scrutinized the impact of population on food security and indicated that the demand for food increases with the increase in population. The author found that a sufficient amount of food is not available to Africa and around 30-million children in Sub-Saharan Africa are malnourished. The study, therefore, concluded the positive relationship between population and food insecurity and argued that an increase in population tends to increase food insecurity. Similarly, Hall, Dawson [9] also indicated the negative relationship between population growth and food security. The study concluded that an increase in population tends to increase food insecurity and ubiquitous malnutrition. Molotoks, Smith [8] worked under the context of the FEEDME "(Food Estimation and Export for Diet and Malnutrition Evaluation)" model to scrutinized the impact of population on global food security. The study revealed the negative relationship between increased population and global food security and concluded that population growth is a significant predictor of malnutrition incidence. Cook, Black [30] also found the negative impact of population on food security and concluded that the probability of food insecurity increases with the increase in population. Considering the above literature, the present study postulates that:

Hypothesis 2 (H2). *There is a relationship between population growth and food insecurity.*

2.3. Food Insecurity and Water Availability

An ample of researchers have conducted their studies on the nexus between water and food security and concluded that the availability of water significantly contributes to food security. For instance, Jiao [31] indicated that water is an essential element for food security and argued that water shortage increases the level of food insecurity. Qureshi, Hanjra [22] believed that water is an essential requirement for agriculture production and thus concluded the positive relationship between water availability and food security. Mahlknecht, González-Bravo [14] conducted a study on the water-energy-food nexus and showed that water and energy are significant predictors of food security. The study concluded that water availability is vital for the irrigation of land crops and food processing. Avgoustaki and Xydis [32] conducted a systematic bibliographical review on the water-energy-food nexus and found that water shortage is among one of the most prominent reasons for food insecurity. Drangert [33] also concluded that water shortage increases the level of food insecurity. Reviewing the above literature, the present study proposes that most of the researchers have scrutinized the impact of water shortage on food security, the relationship between water availability and food insecurity is less focused by the researchers. Present study, therefore, contributes to the existing literature by examining the role of water availability to the food insecurity. Hence, it postulates that:

Hypothesis 3 (H3). *There is a relationship between water availability and food insecurity.*

2.4. Food Insecurity and Research and Development

Undoubtedly, the demand for food continues to grow with the rapid increase in population and urbanization. This increased demand for food necessitates increasing agriculture production. Researchers believe that research and development (R&D) plays a positive role to meet this increased demand for production [18]. For instance, Huesing, Andres [23] stated that the adaptation of agriculture science and technology by farmers has cause higher yields and increased food security. Gaffney, Bing [34] indicated the positive role of R&D to increase agriculture production. The authors stated that R&D is a major contributor to the world's aptitude to produce more food from limited land. Conceição, Levine [19] recognized a food gap of around 70% between the crop calories available in 2010 and expected calories to be demand in 2050. The author suggested that there is a dire need for increased agriculture production to fill this food gap which is possible by the adaptation of agriculture science (pesticides) and technology (tractors). Mok, Tan [21] identified the crucial role of R&D in food security. The authors stated that technology, innovation, and science play a crucial role in producing more food by generating plant varieties with upgraded traits and thus positively contribute to food security. Triangulating the above discussion, the present study argues that the R&D-food security nexus has been discussed by several researchers in their studies. But, to the best of our knowledge, the empirical study on the relationship between R&D and food insecurity is rarely published and most of the researchers theoretically discussed this linkage. Considering the importance of R&D, present study proposes that R&D-food security/insecurity nexus requires an empirical investigation. Thus, it hypothesizes that:

Hypothesis 4 (H4). *There is a relationship between R&D and food insecurity.*

2.5. Moderating Role of Government Stability

Food insecurity is a major threat to the sustainable development of the economy as it results in serious economic problems like poverty, environmental degradation, and public health problems [35]. These economic problems not only create barriers in the achievement of sustainable economic development but also a huge constraint in the accomplishment of sustainable development goals (SDGs) [36]. It is proposed that the achievement of sustainable economic development and the accomplishment of SDGs are the prime concern of the government, therefore the government of any nation plays a crucial role in reducing the level of food insecurity. Moreover, the government of the nation has an explicit role to play in guaranteeing health and food provision to the country's residents to eradicate serious economic problems. Many researchers argued that food security" is the responsibility of governmental authorities "e.g., ministries or departments of agriculture, health, trade or commerce" who implement different policies to control the socio-economic determinants of food insecurity [37]. The present study, therefore, proposes that government stability plays a significant moderating role in the relationship between studied variables. The moderating mechanism of governmental stability is presented in Figure 3. However, to the best of our knowledge, until now, no study has incorporated "governmental stability" as a moderating factor between the socio-economic determinants of food security. The present study, therefore, hypothesized that:

Hypothesis 5 (H5). *Government stability plays a significant moderating role on the association between urbanization and food insecurity.*

Hypothesis 6 (H6). *Government stability plays a significant moderating role on the association between population and food insecurity.*

Hypothesis 7 (H7). *Government stability plays a significant moderating role on the association between water availability and food insecurity.*

Hypothesis 8 (H8). *Government stability plays a significant moderating role on the association between R&D and food insecurity.*

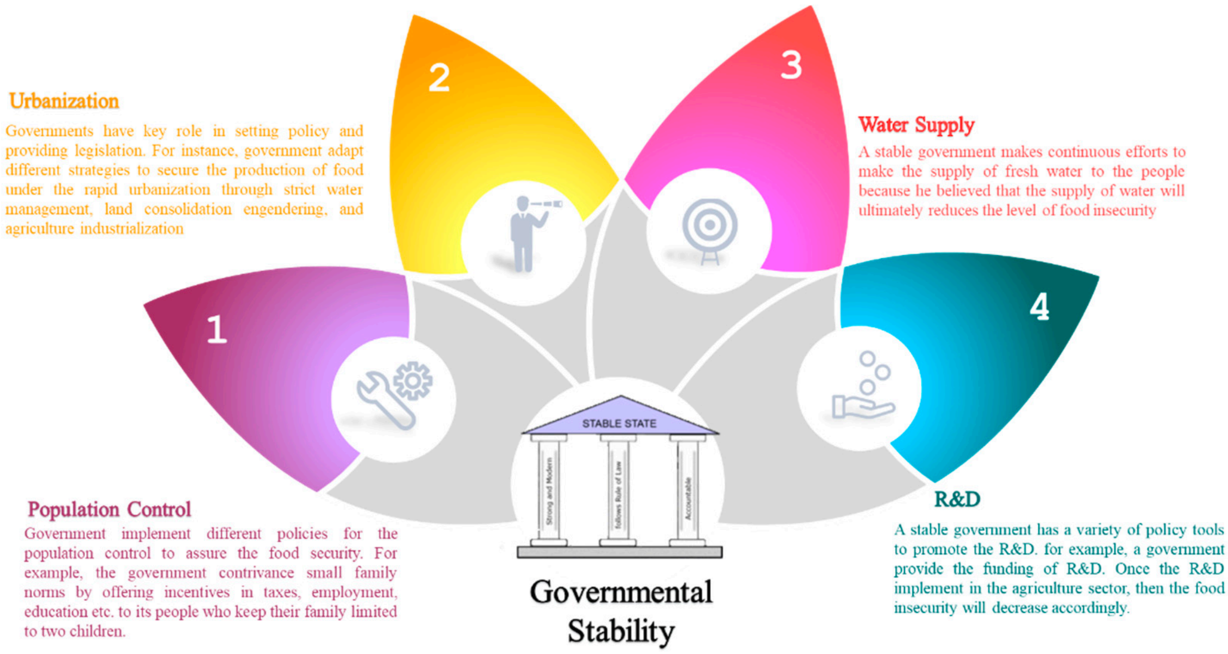

Figure 3. Moderating mechanism of governmental stability; Source: Author generated.

2.6. Theoretical Justification of the Study

The present study uses the food availability decline (FAD) approach, rights-based approach (RBA), and Malthusian theory to justify the theoretical/conceptual model of the study (shown in Figure 4). FAD approach states that the "shortfall or the deficit in the supply of basic foodstuff to the population requirement" is the main reason for food insecurity [38]. The present study, therefore, proposes that rapid urbanization and population growth are significant predictors of food insecurity. The Malthusian theory also supports this proposition. The theory implies that when the growth rate in the population is greater than the food supply then disequilibrium exists, and resultantly people are unable to bring enough food even for their survival, and thus the level of food insecurity increases [39]. The theory further implies that food production does not be able to match rapid growth in population and urbanization which results in severe starvation, and food deprivation [40]. FAO approach suggests that the investments in the "green revolution technologies (R&D)" are intended to increase the level of food supply for the national self-reliance and for export which in turn reduces the level of food insecurity [41]. Thus, the present study believes that investment in R&D can increase food security (and reduces food insecurity). RBA implies that "poor agriculture performance" is the main reason for food insecurity, and the main reason behind this poor performance is "water shortage" [42]. The theory indicated that food production is the responsibility of the country's agriculture sector which requires enough water availability for irrigation; hence, water shortage is a barrier in the agriculture production which leads to insecurity. The present study, therefore, proposes that the availability or the supply of enough water can reduce the food insecurity level. The advocates of the rights-based approach suggest that "enough resources exist in the world to satisfy basic human needs but that inequalities and policies prevent the realization of this goal" [43]. The present study argues that it is the government of any nation that can implement effective policies and laws to certify the rights of people to achieve food security and other basic comforts. The study further argues that the stable government of the nation makes different policies to control the population, rapid urbanization, and promoting R&D investment. Hence, the present study proposes that governmental stability plays a significant moderating role in the relationship between urbanization, population growth, water availability, R&D, and food insecurity.

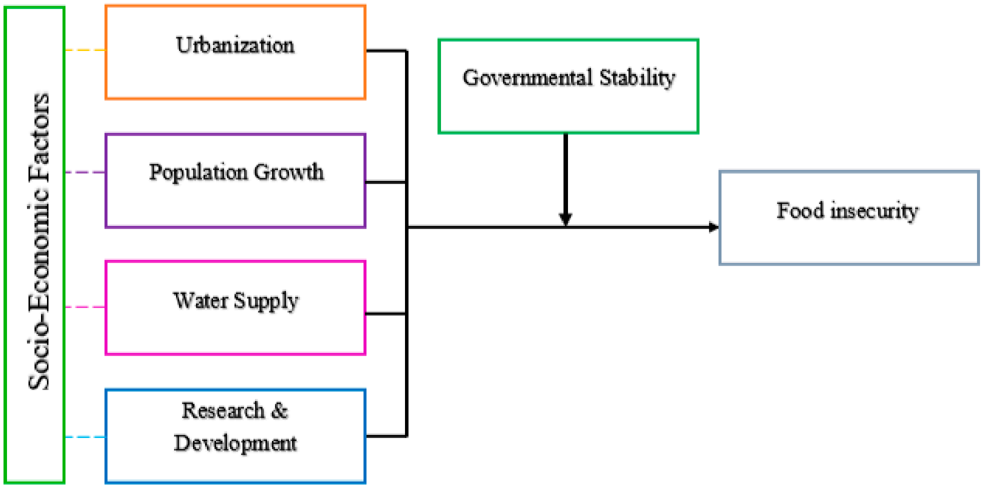

Figure 4. Conceptual model of the study.

3. Data and Methodology

This study utilized time series data for the period of 1990–2019, from world development indicators (WDI), Food and Agriculture Organization (FAO), and World Bank. This study utilized four independent variables; urbanization (Urb), Population growth (POP), Agriculture research (AST), and water resources (WA). The study utilizes a multidimensional food index comprised of food accessibility, availability, and stability as the dependent variable, food insecurity. This study utilized FAO method of computing food insecurity; the value of food security index are above 1.4 and less than 1.4. More than 1.4 values of food index indicate adequate food or energy reserves while less than 1.4 indicates chronic energy deficiency or food insecurity [44]. This study utilized E-Views 7 to investigate the empirical relationship among modeled variables.

Table 1 provides a detailed description of the variables, symbols utilized in equations, and data sources. Table 2 provides descriptive statistics and correlations among all variables. The value of significance of Jarque-Bera statistics for all variables except FS and AST is greater than 0.05% [45]. So this study accepts the null hypothesis that data is normally distributed. Table 3 indicates that the value of correlation among all variables is less than 0.8, threshold for multi-collinearity, which indicates that there is no multi-collinearity among variables. However, FA, FS, and FACC are strongly correlated because their correlation values are greater than 0.8; so this study remove multi-collinearity among FA, FS, and FACC by developing construct for food insecurity through principle component analysis.

Table 1. Variables and Description.

Variable Name	Symbol	Variable Description	Data Source
Food Insecurity	Findex	Food availability + Food accessibility + Food stability	Food and Agriculture Organization
urbanization	Urb	The number of people who are living in urban areas	WDI
Population growth	POP	Population growth (annual %)	WDI
Agriculture Research	AST	Agriculture scientific techniques	FAO, AQUASTAT data.
Water Availability	WA	Annual freshwater withdrawals	WDI
Political Stability	PS	"Estimate of governance (ranges from approximately −2.5 (weak) to 2.5 (strong) governance performance)"	World Bank

Table 2. Descriptive Statistics.

	WA	POP	URB	AST	FA	FS	FACC	FINDEX	PS
Mean	94.81	2.54	3.21	3456.8	104.35	2302.3	174.74	−0.15	−1.70
Median	94.26	2.52	3.12	3453.3	105	2321	171	0.0843	−1.55
Maximum	96.79	2.96	3.77	3678.3	107	2360	187	1.04	−1.1
Minimum	93.95	2.13	2.71	3338.4	101	2134	163	−2.11	−2.81
Std. Dev.	0.93	0.28	0.38	69.51	1.47	58.22	8.25	0.89	0.68
Skewness	0.87	0.00	0.13	1.24	−0.54	−1.30	0.31	−0.55	−0.52
Kurtosis	2.26	1.35	1.32	5.96	2.78	4.08	1.54	2.23	1.56
Jarque-Bera	3.45	2.62	2.76	14.31	1.14	7.54	2.40	1.71	3.03
significance of Jarque-Bera statistics	0.18	0.27	0.25	0.00	0.56	0.02	0.30	0.43	0.22
Observations	23	23	23	23	23	23	23	23	23

Table 3. Correlations Statistics.

WA	1	0.798	0.857	0.008	−0.686	−0.681	−0.738	−0.816	0.698
POP		1	0.991	−0.149	−0.460	−0.599	−0.907	−0.768	0.921
URB			1	−0.129	−0.533	−0.619	−0.895	−0.798	0.898
AST				1	−0.062	0.037	0.124	0.041	−0.141
FA					1	0.602	0.489	0.800	−0.365
FS						1	0.732	0.909	−0.602
FACC							1	0.868	−0.950
FINDEX								1	−0.752
PS									1

4. Results

Before the empirical investigation, this study applied Augmented Dickey-Fuller (ADF) [46] and Phillips and Perron [47] tests to confirm the stationarity of the data. The results of the ADF and PP unit root test are reported in Table 4; results indicate that all variables, population growth, urbanization, agriculture research, and food insecurity, are integrated at the level I(0) while only water availability is stationary at the first difference I(1). However, no variable is integrated at the second difference [I (2)]. Moreover, this study applied principle component analysis to develop a food index, and the results are reported in Table 3. Results indicate that factor loading of all three indicators, food availability (FA), food accessibility (FACC), and food stability (FS), of food insecurity, ranges from 0.845 to 0.934. Similarly, the value of KMO is 0.681; though the value of KMO falls in the range of mediocre but according to Hutcheson and Sofroniou [48] the value of KMO is acceptable and it is worth conducting factor analysis in case of present data. Therefore, this study reduced data in one dimension. Moreover, the value of total variance explained (TVE) indicates that 78% variation in food insecurity is explained by FA, FS, and FACC.

Table 4. Unit Root Test.

Variables	**Augmented Dickey-Fuller**		**Phillips-Perron**	
	I(0)	**I(1)**	**I(0)**	**I(1)**
WA	−6.901 *		−3.722 *	
POP	−3.749 *		−1.122	−5.451 *
Urb	−1.273	−4.992 *	−1.516	−3.992 **
AST	−1.978	−4.300 *	−1.630	−4.937 *
FS	−0.895	−3.843 *	−1.324	−9.452 *
FA	−0.725	−4.322 *	−0.736	−4.315 *
FACC	−1.175	−3.235 *	−1.023	−6.379 *
Findex	−1.160	−4.736 *	−1.007	−5.657 *
Principle Component Analysis				
Indicators	Factor Loadings	KMO	Bartlett's Test of Sphericity	TVE
FA	0.845	0.680	35.071 (0.000)	78.721
FS	0.934			
FACC	0.881			

* and ** indicates the significance level at less than 5% and less than 10%.

For motivation, the value of KMO falls in the range of mediocre according to and is acceptable.

For the purpose to investigate the impact of socio-economic factors on food insecurity, this study develops the following models.

Findex = $\beta_0 + \beta_1$ WA + β_2 pop + β_3 Urb + β_4 AST + ε——Model 1.

Findex = $\beta_0 + \beta_1$ WA + β_2 pop + β_3 Urb + β_4 AST + β_5 PS * WA+ ε——Model 2.

Findex = $\beta_0 + \beta_1$ WA + β_2 pop + β_3 Urb + β_4 AST + β_5 PS + β_5 PS * pop + ε ——Model 3.

Findex = $\beta_0 + \beta_1$ WA + β_2 pop + β_3 Urb + β_4 AST + β_5 PS + β_5 PS * Urb + ε——Model 4.

Findex = $\beta_0 + \beta_1$ WA + β_2 pop + β_3 Urb + β_4 AST + β_5 PS + β_5 PS * AST + ε——Model 5.

Before the empirical investigation of above mentioned five models, this study utilized ARDL bound test to investigate the long-run co-integration among the series.

The result of ARDL co integration bound test are reported in Table 5. The values of F. Statistics for all Models are greater than lower and upper bound values, so the study concludes that long run association among the series exists.

Table 5. Long Run Co-integration: ARDL Bound Test Approach.

Test Statistic		**ARDL Bounds Test**							
		Model 1		**Model 2**		**Model 3**		**Model 4**	
		Value	**k**	**Value**	**k**	**Value**	**k**	**Value**	**k**
F-statistic		8.907	4	7.929	6	11.352	6	9.513	6
Critical Values Bonds	Significance	I0 Bound	I1 Bound	I0 Bound		I1 Bound			
	10%	2.45	3.52	2.12		3.23			
	5%	2.86	4.01	2.45		3.61			
	2.5%	3.25	4.49	2.75		3.99			
	1%	3.74	5.06	3.15		4.43			

After confirmation of long-run cointegration, this study employed CUSUM (Cumulative Sum of Recursive Residuals) and CUSUMSQ (Cumulative Sum of Square of Recursive Residuals), to ensure the stability and trustworthiness of the models 1–5 [49,50]. Figures 5–9 indicate that models are stable and satisfy the truth worthiness. The study also applied the Lagrange multiplier (LM) test, the Buresh Pagan test, to test serial correlation and heteroscedasticity among series. The results of the LM and Buresh Pagan test indicate that the T value is less than 2, so the study accepts the null hypothesis of no serial correlation and no heteroscedasticity. After confirmation of the model's stability and reliability, this study applied ARDL co-integration technique to estimates short-run and long-run estimates among modeled variables. The results of diagnostic tests, the short-run and long-run symmetric impact of socio-economic factors on food insecurity are reported in Tables 6 and 7.

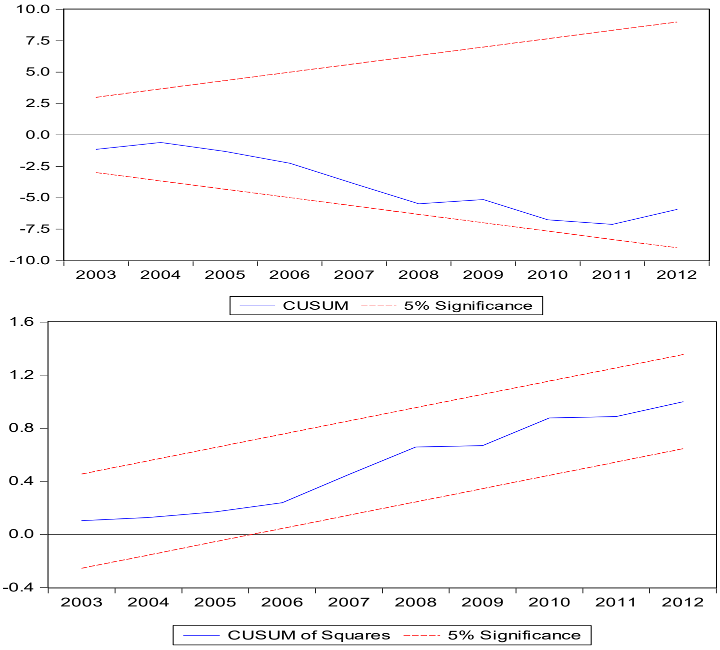

Figure 5. CUSUM and CUSUM square for Model 1.

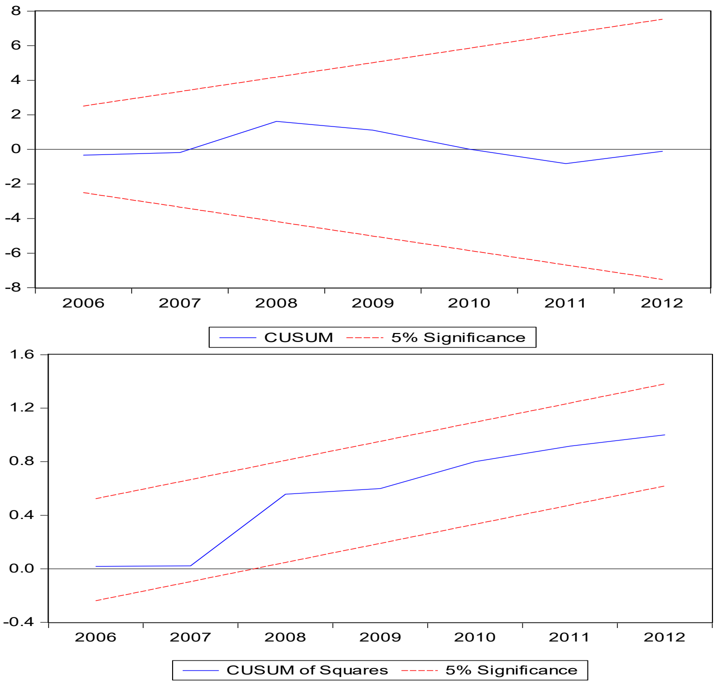

Figure 6. CUSUM and CUSUM square for Model 2.

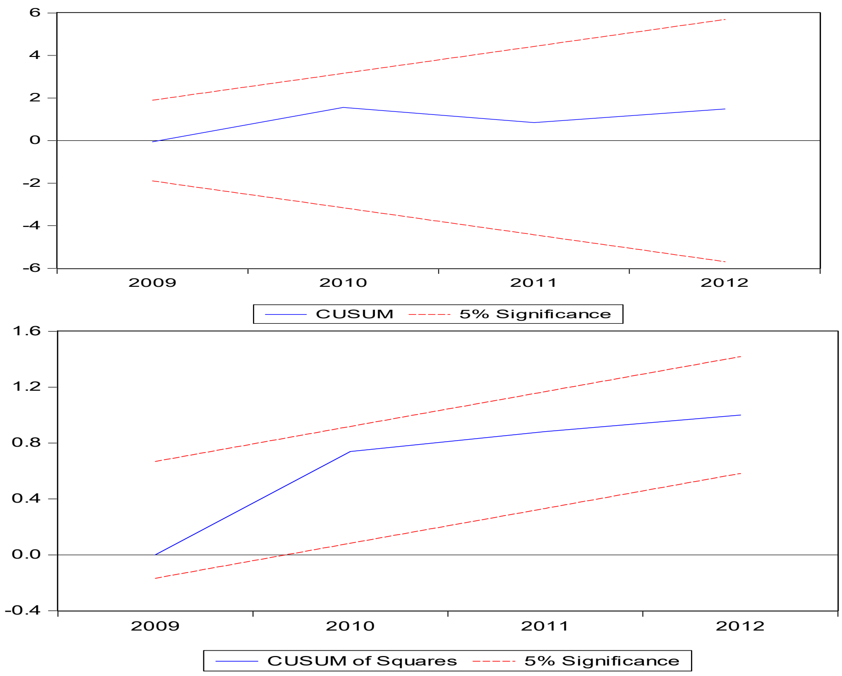

Figure 7. CUSUM and CUSUM square for Model 3.

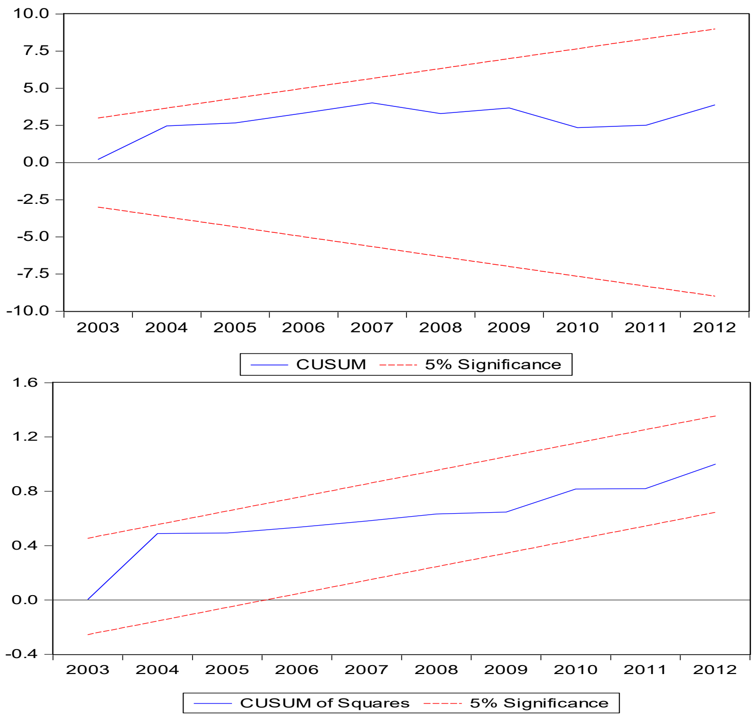

Figure 8. CUSUM and CUSUM square for Model 4.

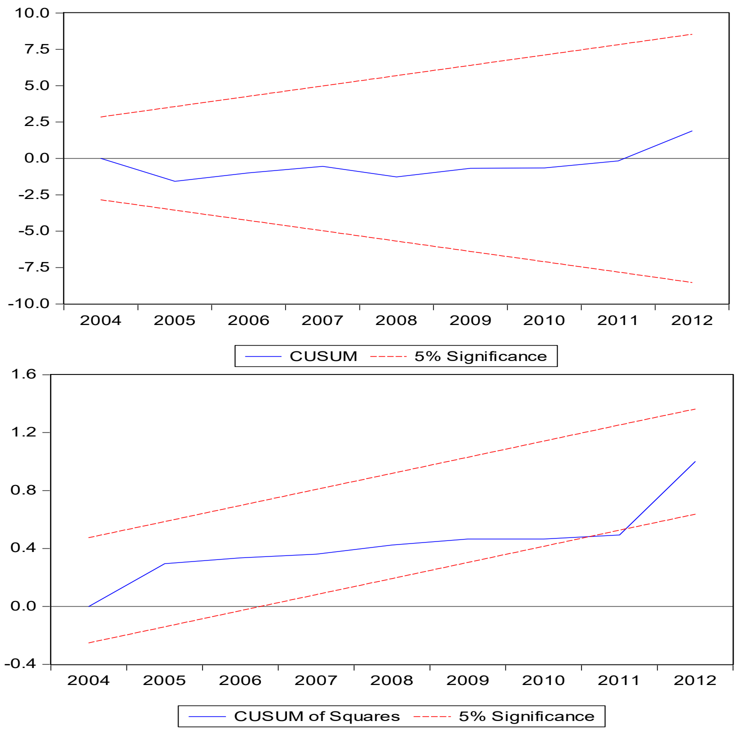

Figure 9. CUSUM and CUSUM square for Model 5.

The short run results are presented in Table 6 while long run empirical estimates are reported in Table 7. Table 6 indicates that all five models are stable and if any shock that deviate them from their growth path, they will converge toward equilibrium. The error correction term (ECT) indicates that Model 1 converges toward equilibrium with 81% speed of convergence while models 2–5 will converge with the speed of 98%, 90%, 95%, and 49% respectively. Moreover, political stability has a significant moderating impact on the relationship of urbanization and food security in the short run as well as in the long-run period. However, political stability also moderates the relationship between agriculture research and food insecurity; water resources and food insecurity in the long run.

Results of Tables 6 and 7 indicates that, in model 1 water resources and agriculture research have a significant and negative impact on food insecurity in the short-run (−7.52 *, −0.06 *], and in long-run period (−1.98 **, −27.07 *, 0.10 *) while urbanization and populations growth has a significant and positive impact on food insecurity in short-run (15.92 *, 39.35 *) as well as in long run period (19.74 **, 27.07 *).

Model 2 indicates that political stability has a negative and significant effect on food insecurity in the short-run (−34.06 *) and long-run period (−8.87 *). Moreover, the R-value of model 2 has been increased from 0.83 to 0.95 when the study adds PS in model 1. An interaction term for WA, POP, urbanization, and agriculture research has been introduced in models 3–5 to capture the moderating impact of political stability among modeled variables. Results indicate that political stability significantly moderates the relationship of water resources, urbanization, and agriculture research with food insecurity. Moreover, results depict that in long run, political stability strengthens the association of WA and AST with food insecurity (24.35 *, 43.54 *) while it weaken the association of urbanization with food insecurity (−84.63 *) in the long run.

Table 6. ARDL Short Run Estimates.

Dependent Variable: Food Insecurity					
Variable	Model 1	Model 2	Model 3	Model 4	Model 5
D(WA)	−7.52 * [2.61] (−2.88)	−12.31 [12.10] (−1.02)	0.73 [0.51] (1.43)	0.60 [10.28] (0.06)	−4.526 * (2.003) [−2.260]
D(WA(-1))	0.97 [0.56] (1.72)			−1.13 [0.87] (−1.30)	−2.222 (1.970) [−1.128]
D(WA(-2))					1.839 * (0.508) [3.621]
D(POP)	39.35 * [14.63] (2.69)	91.06 * [8.53] (10.67)	79.93 * [7.62] (10.49)	107.32 * [45.32] (2.37)	6.355 * (2.833) [2.243]
D(POP(-1))	13.13 ** [6.68] (1.97)	51.12 * [4.59] (11.14)	49.15 * [4.78] (10.28)	82.65 * [40.93] (2.02)	
D(URB)	15.92 * [6.04] (2.64)	23.39 * [3.10] (7.54)	−12.85 [14.73] (−0.87)	20.92 * [7.03] (2.98)	
D(URB(-1))			−41.71 * [12.51] (−3.33)	9.12 [11.53] (0.79)	
D(AST)	−0.06 * [0.01] (−6.00)	−0.02 * [0.01] (−2.60)	0.00 [0.00] (0.44)	0.00 [0.01] (0.60)	−0.002 ** (0.001) [−1.938]
D(AST(-1))		0.00 * [0.00] (2.94)		0.01 [0.00] (1.49)	
D(PS)		−34.06 * [14.76] (−2.31)	−34.06 * [14.76] (−2.31)	0.10 [37.71] (0.00)	−0.709 (0.490) [−1.447]
D(PS(-1))		−46.66 * [10.93] (−4.27)		21.48 [42.70] (0.50)	
D(WA * PS)		21.04 [24.16] (0.87)			
D(Urb * PS)			69.98 [30.18] (2.32)		
D(Urb * PS(−1))			89.98 * [21.58] (4.17)		
D(pop * PS)				6.87 [69.93] (0.10)	
D(pop * PS(-1))				−43.44 [88.72] (−0.49)	
ECT	−0.81 * [0.25] (−3.22)	−0.98 * [0.12] (−8.05)	−0.90 * [0.12] (−7.20)	−.095 * [0.24] (−3.95)	−0.49 * (0.22) [−2.26]

Note: The standard error are in the brackets [ ] while t values are given in ( ), * and ** indicate significance at less than 5% and 10%.

Table 7. ARDL Long Run Estimates.

Variable	Model 1	Model 2	Model 3	Model 4	Model 5
WA	−1.98 ** [1.05] (−1.88)	−12.57 [12.22] (−1.03)	0.81 (1.31) [0.62]	1.52 [1.47] (1.03)	−1.64 * (0.30) [−5.44]
POP	27.07 * [12.73] (2.13)	41.54 * [7.50] (5.54)	18.99 * (1.82) [10.44]	87.45 (0.64) [135.97]	1.54 (1.35) [1.14]
URB	19.74 ** [10.29] (1.92)	23.87 [4.83] (4.94)	48.24 * (1.37) [35.15]	6.15 [19.22] (0.32)	
AST	0.10 * [0.02] (5.00)	−0.01 * [0.00] (−4.36)	0.00 (−1.47) [0.00]	−0.01 [0.01] (−0.83)	0.00 (0.00) [1.69]
PS		−8.87 * [2.27] (−3.90)	45.43 * (1.30) [34.84]	−56.89 * [122.64] (−0.46)	−0.59 (0.34) [−1.75}
WA * PS		24.35 * [4.55] (5.35)			
Urb * PS			−84.63 * (−1.21) [69.86]		
POP * PS				123.25 [244.27] (0.50)	
AST * PS					43.54 * (26.55) [5.41]
C	189.88 [92.73] (2.05)		−36.12 (−0.67) [53.78]	−52.95 [108.58] (−0.49)	25.34 (3.25) [7.79]
R. Square	0.83	0.95	0.98	0.59	0.92
LM Test	1.234 (0.33)	3.497 (0.21)	37.191 (0.118)	4.127 (0.190)	3.221 (0.09)
Breusch-Pagan-Godfrey	0.851 (0.58)	1.513 (0.28)	3.225 (0.113)	10.710 (0.236)	2.11 (0.15)

Note: The standard error are in [ ] while t values are given in ( ), * and ** indicate significance at less than 5% and 10%.

5. Discussion

The present study attempts to explain the role of socio-economic factors in food insecurity with the moderating role of governmental stability in the context of Pakistan. Results of the study reveal interesting findings; first, the study reveals the negative relationship between water availability and food insecurity. This states that the availability of water reduces food insecurity. The possible justification behind this relationship is that water is a prerequisite for agriculture production [22] and the supply of water is vital for the irrigation of land crops and food processing [14].

Without enough supply of water farmers are unable to irrigate their agricultural land which adversely affects their crop yield and agriculture production which in turn reduces the availability, access, and supply of food, and thus leads to food insecurity [15]. In Pakistan food insecurity is directly related with agriculture production; as empirical evidence revealed that the share of agriculture sector in total gross national production is decreasing with every passing years [51].

The study, therefore, considers the supply of water as a significant driver of food security. Results are aligned with [32,33]. The study further found that the negative relationship between water availability and food insecurity becomes stronger in the presence of political stability. This is so because a stable government makes continuous efforts for better water management systems to end the hunger, malnutrition and food insecurity.

Second, the study found that urbanization and population growth has a positive association with food insecurity. This implies that an increase in population leads to food insecurity; so increase in population increases the demand for food that imposes pressures on agriculture production level. Moreover, the use of land for urban development programs instead of agriculture production [9] enhances food insecurity. The study, therefore, indicated that population growth is having adverse impacts on the food production and food prices. Results are supported by Hall, Dawson [9] and Molotoks, Smith [8]. Moreover, urbanization reduces the availability, access, and supply of adequate food to the people because urbanization transforms the productive land into its non-productive usage which reduces arable land and thus the availability and access of quality food affected [13]. Urbanization creates food insecurity by changing consumption pattern, food production and supply processes. Therefore, urbanization causes changing life style, nutritional habits and food supply strategies that are key contributor to food insecurity. Moreover, the land adjacent to urban areas become expensive and small farmer often sell their land for non-agriculture uses which lead to more urban expansion and food insecurity.

Further, the study found that governmental stability weakens the positive relationship between urbanization and food security. The possible justification behind this is that the government of any nation plays a key role in setting the policies and regulations regarding urbanization and the provision of adequate and quality food to the people [52]. In this regard, the governmental authorities of the nation adopt different approaches to secure the availability, access, and supply of food under rapid urbanization through promoting land amalgamation, agriculture industrialization, and stringent water management strategies [53]. The study, therefore, concluded the buffering role of governmental stability on the association between urbanization and food insecurity.

Finally, the study shows that the R&D in the agriculture sector negatively contributes to food security in Pakistan. This is so because the adaptation of agriculture science and technology increases the opportunities to provide higher yields of seed, fertilizer, and machinery to the farmer, which enhances the level of food security by increasing supply, availability, and access to food [23]. The study, therefore, concludes the negative relationship between agriculture research and food insecurity. Results are aligned with Mok, Tan [21] and Conceição, Levine [19]. Moreover, the study shows that this negative relationship becomes stronger in the presence of political stability. This is so because a government utilizes policy tools to promote and adapt agriculture scientific techniques.

6. Conclusions

6.1. Contribution and Findings

The present study attempts to explain the role of socio-economic factors in food insecurity with the moderating role of governmental stability in the context of Pakistan. In this regard, the study utilized time series data for the period of 1990–2019, from world development indicators (WDI), Food and Agriculture Organization (FAO), and World Bank. The study applied an Auto-regressive distributive lag (ARDL) co-integration approach to test the hypothesized relationships among modeled variables.

The study found a negative and significant association of water resources and agriculture research with food insecurity while urbanization and population growth has a significant and positive impact on food insecurity in the short-run as well as in the long-run period. Moreover, the study found that political stability has a negative and significant association with food insecurity in the short-run and long-run periods. Results also indicated that political stability significantly strengthens the relationship of water resources, and agriculture research with food insecurity while political stability weakens the relationship of urbanization and food insecurity significantly.

6.2. Policy Implication

In light of the above discussion; this study suggests that the local or regional government needs to conserve water to overcome the shortage of water effectively. Moreover, the government ensures efficient use of water by the farmers, consumers, and firms that ultimately increase the availability of water resources for all. Further, the study suggested that government should plan vertical urban development to avoid a shortage of arable land. The study also suggests that government should increase its investment in agriculture R&D to increase food security. A stable government can implement efficient institutional reforms to deal with the problem of food insecurity at the local and regional levels. Furthermore, this study suggests that the government should adopt different policies to control the population and to ensure food security.

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