CHAPTER 4

EMPIRICAL RESULTS AND DISCUSSION

In this section, Porter' Diamond Model is employed to analyze the situation of rice production in Cambodia. Rice production model examines the input factors (seed use, machinery, irrigation, harvested area and fertilizer use) impact on the outputs of rice production. Economic growth model is introduced to investigate the relationship between real GDP growth and rice export based on ARDL econometric technique. ARIMA is also provided to estimate the historical forecasting of rice production in order to explore the best model to predict rice production in Cambodia.

4.1 Situation of Rice Production in Cambodia

Rice plays a crucial role in developing Cambodian economic. It occupies over 80 percent of the total Cambodian households cultivated area, primarily use traditional techniques for growing rice. For Cambodian farmers, rice is considered to be the main source of income and sustenance. Overall, agriculture accounts for 36 percent to GDP in 2012 (World Bank, 2014). However, rice sector faces so many obstacles in Cambodia such as lack of irrigation system, financial support, marketing, and modern technology.

Rice production has mostly increased through rises in yields of dry season rice and wet season rice 1.85 percent per year and 0.76 percent per year respectively. The yields of wet season rice increased from 2.87 tonnes per hectare in 2010 to 2.92 tonnes per hectare in 2013. Therefore, it is concluded that the increase in yields of wet season rice is seen in the context of enhancements from the past. Due to Cambodian farm households are able to access to fertilizers, irritation, seeds and other input.

Table 4.1: Provincial Production of wet season rice, Cambodia, 2013-2014 (continued)

Provinces	Wet season rice			
	Cultivated area (ha)	Harvested area (ha)	Yield (t/ha)	Production (t)
Banteay Meanchey	230,630	206,998	2.821	584,007
Battambang	296,993	270,070	2.794	754,700
Kampong Cham	167,819	166,024	3.330	552,860
Kampong Chnang	120,651	118,917	3.067	364,769
Kampong Speu	115,629	115,629	3.072	355,259
Kampong Thom	215,191	210,090	2.428	509,998
Kampot	135,095	135,095	3.065	414,115
Kandal	41,110	40,861	3.097	126,541
Koh Kong	10,374	10,353	2.788	28,866
Kratie	32,860	31,117	2.876	89,508
Mondulkiri	22,920	22,893	2.481	56,798
Phnom Penh	12,151	12,141	2.865	34,787
Preah Vihear	77,622	74,394	2.870	231,540
Prey Veng	279,894	278,891	2.985	832,545
Pursat	110,783	104,453	3.331	347,951
Rathanakiri	27,172	25,197	2.203	55.510
Siem Reap	183,845	179,065	2.760	494,271

Table 4.1: Provincial Production of wet season rice, Cambodia, 2013-2014

Provinces	Wet season rice			
	Cultivated area (ha)	Harvested area (ha)	Yield (t/ha)	Production (t)
Preah Sihanouk	16,483	16,483	2.950	48,625
Stung Treng	27,664	25,288	2.570	64,990
Svay Rieang	166,549	166,313	2.726	453,338
Takeo	201,566	201,566	3.447	694,847
Oddor Meanchey	64,705	63,921	2.524	161,311
Kap	3,530	3.530	3.213	11,342
Pailin	6,485	6,232	3.333	20,773
Total	2,567,723	2,485,521	2.925	7,271,251
Last year (2012)	2,512,038	2,484,832	2.872	7,136,139
Growth rate (%)	2.22	0.028	1.85	1.89
Compare	55,685	689	0.054	135,112

Source: Ministry of Agriculture Forestry and Fisheries (2014)

Table 4.2: Provincial Production of dry season rice, Cambodia, 2013-2014 (continued)

Provinces	Wet season rice			
	Cultivated area (ha)	Harvested area (ha)	Yield (t/ha)	Production (t)
Banteay Meanchey	12,398	11,745	3.820	44,862
Battambang	10,582	10,564	3.873	40,911
Kampong Cham	53,569	53,569	4.245	227,422
Kampong Chnang	35,566	35,446	4.138	146,689
Kampong Speu	645	640	3.298	2,111
Kampong Thom	41,540	41,540	4.367	181,391
Kampot	9,715	9,715	4.131	40,130
Kandal	65,058	65,058	4.178	271,835
Koh Kong	-	-	-	-
Kratie	14,116	14,083	4.257	59,946
Mondulkiri	-	-	-	-
Phom Penh	1,440	1,440	3.500	5,040
Preah Vihear	75	75	2.907	218
Prey Veng	92,201	92,201	4.646	428,366
Pursat	9,963	9,963	4.182	41,661

Table 4.2: Provincial Production of dry season rice, Cambodia, 2013-2014

Provinces	Wet season rice			
	Cultivated area (ha)	Harvested area (ha)	Yield (t/ha)	Production (t)
Banteay Meanchey	12,398	11,745	3.820	44,862
Rathanakiri	-	-	-	-
Siem Reap	18,040	-	3.650	202,285
Preah Sihanouk	-	-	-	-
Stung Treng	141	141	3.496	493
Svay Rieang	20,422	20,400	4.209	85,864
Takeo	96,532	96,532	4.834	466,632
Oddor Meanchey	600	600	4.500	2,700
Kap	20	20	3.609	72
Pailin	1,674	1,674	3.900	6.529
Total	484,697	483,446	4.383	2,118,710
Last year (2012)	495,507	495,465	4.349	2,154,801
Growth rate (%)	-2.18	-2.43	0.76	-1.67
Compare	-10,810	-12,019	0.033	-36,091

Source: Ministry of Agriculture Forestry and Fisheries (2014)

Table 4.3.B: Rice Production, Cambodia, 2004 - 2013

Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Average growth rate (%)
Cultivated area (ha)	2,374,175	2.479	2.489	2.621	2.746	2.836	2.970	3.173	3.117	3.163	6.00
-wet season (t/ha)	2,075,646	2.261	2.272	2.413	2.540	2.620	2.760	2.920	2.872	2.925	6.95
-dry season (t/ha)	298529	3.901	3.938	3.938	4.030	4.126	4.201	4.406	4.349	4.383	2.39
Harvested area (ton)	2109050	5,986,179	6264123	6727127	7175473	7585870	8249452	8779365	9290940	9389961	12.51
-wet season (ton)	1815619	4734300	4973690	5363690	5722242	6001385	6548709	6700439	6700439	7271251	13.21
-dry season (ton)	293431	1251879	1290429	1363437	1453331	1584485	1700743	2078926	2078926	2118710	10.41

Source: Ministry of Agriculture, Forestry, and Fisheries, Cambodia (2014)

Table 4.4.B: Rice Production, Cambodia, 2004 - 2013

Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Average growth rate (%)
Yield (t/ha)	1.977	2.479	2.489	2.621	2.746	2.836	2.970	3.173	3.117	3.163	6.00
-wet season (t/ha)	1.725	2.261	2.272	2.413	2.540	2.620	2.760	2.920	2.872	2.925	6.95
-dry season (t/ha)	3.536	3.901	3.938	3.938	4.030	4.126	4.201	4.406	4.349	4.383	2.39
Production (ton)	4170284	5,986,179	6264123	6727127	7175473	7585870	8249452	8779365	9290940	9389961	12.51
-wet season (ton)	3132581	4734300	4973690	5363690	5722242	6001385	6548709	6700439	6700439	7271251	13.21
-dry season (ton)	1037703	1251879	1290429	1363437	1453331	1584485	1700743	2078926	2078926	2118710	10.41

Source: Ministry of Agriculture, Forestry, and Fisheries, Cambodia (2014)

Table 4.3.C: Rice Production, Cambodia, 2004 - 2013

Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Average growth rate (%)
Consumption (ton)	1905896	2013533	2053983	2096025	1970270	1979214	2076542	2108022	2142178	2137878	1.21
Deficit or surplus of white rice (ton)	416118	1319571	1433880	1649640	2025033	2244598	2516752	2780328	3090452	3090452	64.26
Deficit or surplus of raw rice (ton)	650184	2061830	2240438	2577562	3164114	3507185	3932425	4344264	4735964	4828832	64.26

Source: Ministry of Agriculture, Forestry, and Fisheries, Cambodia (2014)

Overall, cultivated area has increased on average approximately 2.84 percent every year (see Table 4.3.A). Similarly, the growth rate on average of wet season harvested area and dry season harvested area approximately 3.68 and 6.47 percent respectively. Therefore, it is concluded that the average growth rate of dry season of each factor has increased faster than the average growth rate of dry season (see Table 4.3.A).

As Table 4.3.B stated that the yield growth rate on average of wet season rice and dry season rice around 6.95 percent and 2.39 percent respectively. It is concluded that the yield growth rate on average of wet season rice has increased faster than dry season rice. Due to the fact that Cambodian farmers can only grow dry season rice for the small amount of total land and they have enough time and ability to take care of their rice and the yield of dry season rice has a higher degree than wet season rice. Presently, Cambodia has moved from rice deficit to surplus (see Table 4.3.C). It is typically consent that Cambodian moved into rice surplus since 1995.

According to Figure 4.1, wet season crop glowed mostly in some provinces around Tonle Sap Lake such as Battambang, Banteay Meanchey, Siem Reap, Kampong Thom, Pursat, Kampong Chhnang, Kampong Cham, Prey Veng, Svay Rieng Takaew, Kampot and Kampong Speu. Similarly, Figure 4 shows that the majority of dry season crop planted around Tonle Sap Lake with exception of Takeo, Kandal, Prey Veng and Kampong Cham. Cultivated crop area for wet and dry seasons show a weak relationship between the areas planted to wet season rice and the area planted to dry season rice throughout provinces.

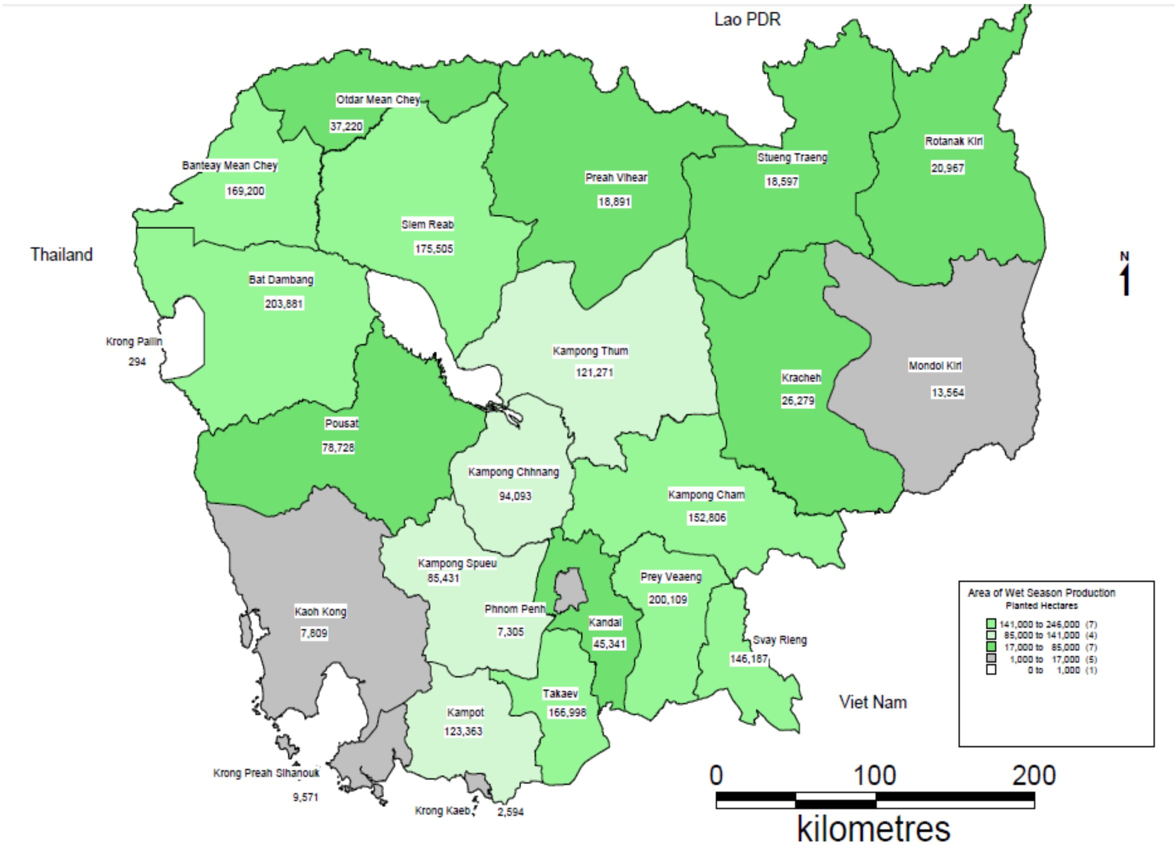


Figure 4.1: Area of Wet Season Crop under Cultivation 2001-2002

Source: Agrifood Consulting International (2002)

There is very little dry season rice is cultivated in Cambodia (see Figure 4.2). Due to the lack of irrigation system, financial support, and government incentive. The levels of yield and cropping intensities in rice production are low compared with neighboring countries (Thailand, Vietnam) with similar ecosystems since 2012. There is because of using mixed seed varieties, poor soil fertilizer, and low levels of farm inputs such as pesticides, fertilize and timely water application (Agrifood Consulting International 2002).

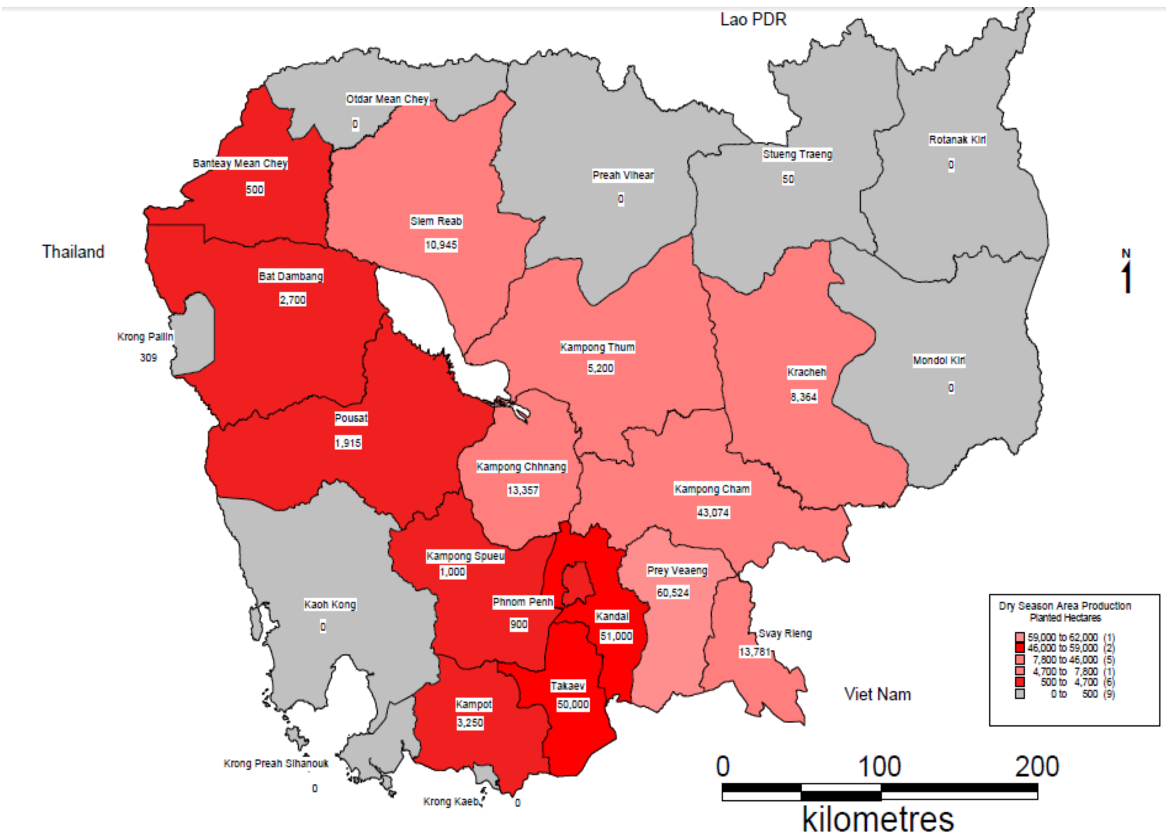


Figure 4.2: Area of Dry Season Crop under Cultivation 2001-2002

Source: Agrifood Consulting International (2002)

Despite most farmer households have relied on agricultural sector especially rice production, there are so many key issues to be solved in order to improve standard of living of farm households. According to Agrifood Consulting International 2002, indicated that funds from commercial banks and microfinance institutes have been limited access for rice value chain in Cambodia. There is a big issue for farmers to receive acceptable big loans for inputs especially fertilizer and emergency needs due to higher interest rate. In some cases, farm households would prefer to borrow money from traders, middlemen, and retailers, with the money inputs lent in exchange for a quality of rice at harvested time. In other cases, farmers could not afford for emergency needs and unforeseen cases, therefore, farm households have to force themselves to borrow money with higher interest rate up to 20 percent per month (Agrifood Consulting International, 2002).

In order to analyze the situation of rice production responses in Cambodia, Port's diamond model would be introduced to investigate why one country is better than other countries in term of international trade in specific industry. This model tries to seek the possible factors that could effect on competitiveness of industry or nation. It is stated that there are four critical factors are could be considered to examine competitiveness of the industry or nation such as factor conditions, demand conditions, firm strategy, structure and rivalry, and related and supporting industries are important factors of diamond model. However, it also has two significant exogenous factors that indirectly impact on the model which are government and chance. The model deeply explains the specific factors that could directly influence on Cobb-Douglas of rice production function in which land, labor and capital are the key inputs. Diamond model is suite to analyze the competitiveness of rice industry and nation based on key input factors, government intervene, opportunities, competitors, and structure and strategy.

4.2 Porter's Diamond Model

4.2.1 Factor Conditions

Fertilizer is used by most of farmer households in Cambodia, as the report of Cambodia Socio-Economic Survey in 2004 and 2007 (CSES) stated that 77 to 78 percent of wet season and 87 to 94 percent of dry season rice obtained chemical fertilizer (see Table 4.4). According to CSES data, both average fertilizer price paid by farmers and the quantity of fertilizer used by farmers was low which about 72 percent and 105 kg/ha for wet and dry season rice in 2004, respectively. Due to the fertilizer price had sharply increased in 2007 caused the amount of fertilizer use per hectare had remarkably decreased. According to Yu and Diao (2012), the amount of fertilizer use in Cambodia is below the nationally requirement rate. As Figure 4.3 shows that farmer households on average used 332 kilograms of fertilizer in Vietnam and 135 kilograms in Thailand from 2004 to 2012, which similarly geographical and temperature conditions with Cambodia.

Table 4.4: Fertilizer use in Cambodia in 2004 and 2007

	Wet season rice		Dry season rice	
	2004	2007	2004	2007
International urea price ($/ton)*	200	415	200	415
Famer price ($/ton)**	350	600	350	600
Average exchange rate (Riels/$)***	4021	4032	4021	4032
Calculated fertilizer use (kg/ha)	72.1	35.1	105.4	92.0

Note: Fertilizer use in quantity is not reported in the survey. * is drawn from IFDC (2008); ** is from CDRI (2008) in which urea price $350-$510 per ton, and DAP $450-$1,080 in provincial markets in 2007; and *** is from IMF (2009). Source: International Food Policy Research Institute (2011)

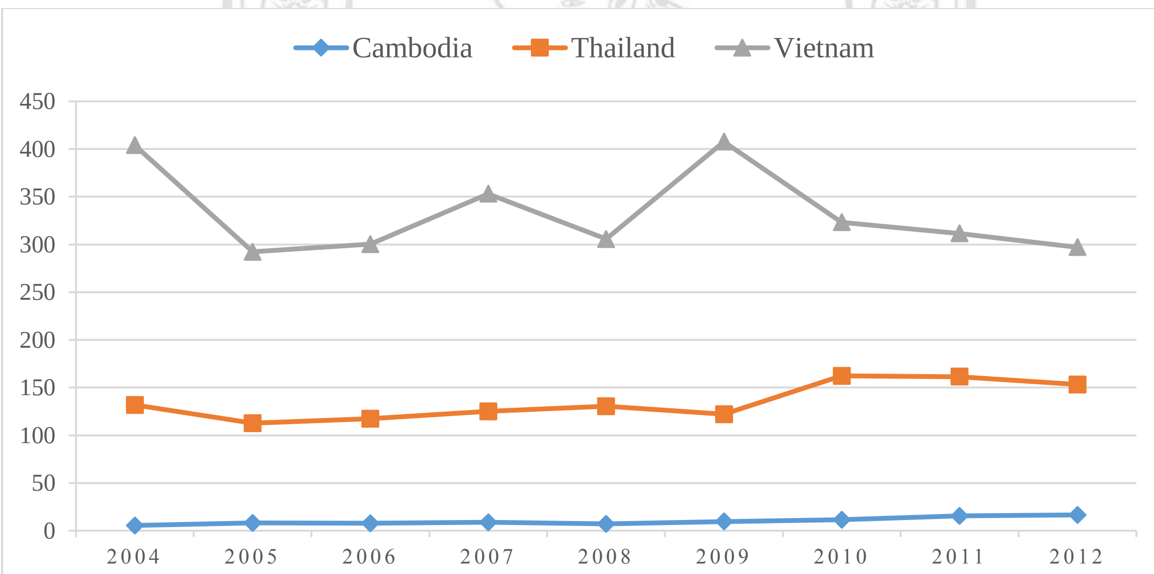


Figure 4.3: Fertilizer Consumption in Three Countries (kilograms per hectare of arable land)

Source: Data from USDA (2014)

In 2004, irrigation was approximately 11.5 percent of wet season rice and 50 percent of dry season rice area based on CSES 2004 and 2009 (see Table 4.5). Due to the price of fuel had increased and better weather condition caused the shares of irritated area use in total paddy field decreased to 8 percent for wet season rice and 36 percent for dry season rice (see Table 4.5).

Table 4.4: Irrigation use in Cambodia, 2004-2007

	Wet season rice		Dry season rice	
	2004	2007	2004	2007
Share of plot using irrigation (%)	14.9	9.4	40.9	38.4
Share of area using irrigation (%)	11.5	8.1	50.1	36.0

Source: Data from CSES 2004 and 2007, cited in Yu and Diao (2012)

Irrigation coverage in Cambodia is lower than Thailand and Vietnam (see Figure 4.4). According to FAO (2014), the irrigation share of total arable land on average of Cambodia, Thailand and Vietnam is approximately 9 percent, 41 percent and 70 percent respectively. Furthermore, majority of irrigation systems in Cambodia are in state of heavy deterioration and only 20 percent of irrigation systems are fully functional (Yu and Diao, 2011).

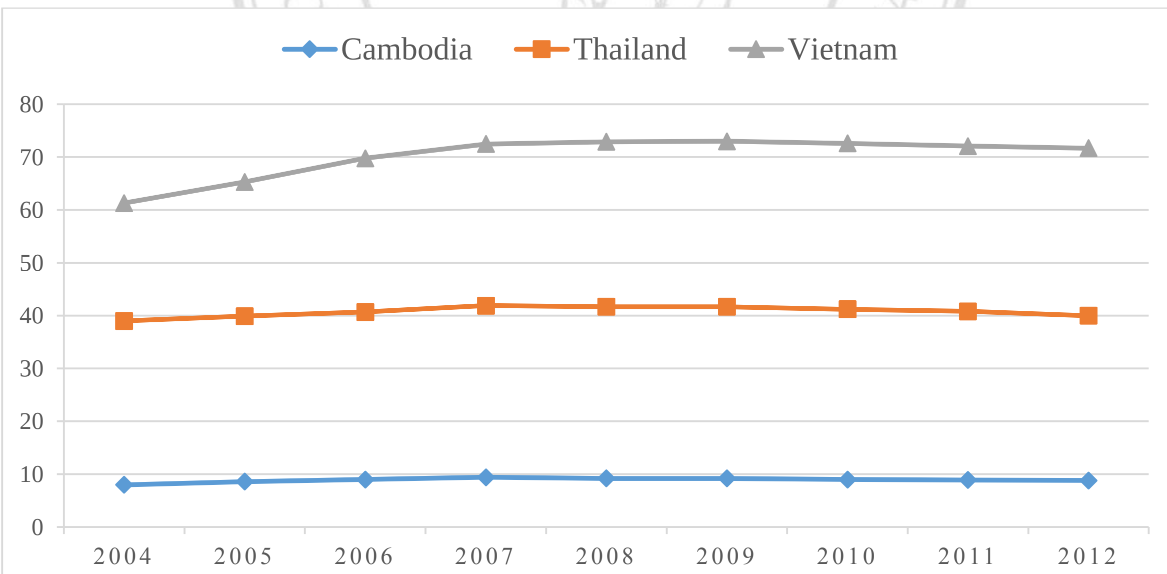


Figure 4.4: Irrigation in Three Asean Countries (share of irrigated area in total arable area in percent)

Source: Data from FAO (2014)

4.1.2 Demand Factor (Domestic Consumption)

Rice is a staple food in Cambodia, which provides calorie intake to Cambodian households approximately 65% in 2004 (FAO, 2009). According to International Rice Research Institute (2014), Cambodian needs calories intake from rice is higher than neighboring countries (Vietnam, Thailand) (see Figure 4.5). Rice provides the huge majority of calories for Cambodian households, Vietnamese households and Thai households on average 1504 Kilocalories per day, 1413 Kilocalories per day and 1190 Kilocalories per day from 2004 to 2009, respectively.

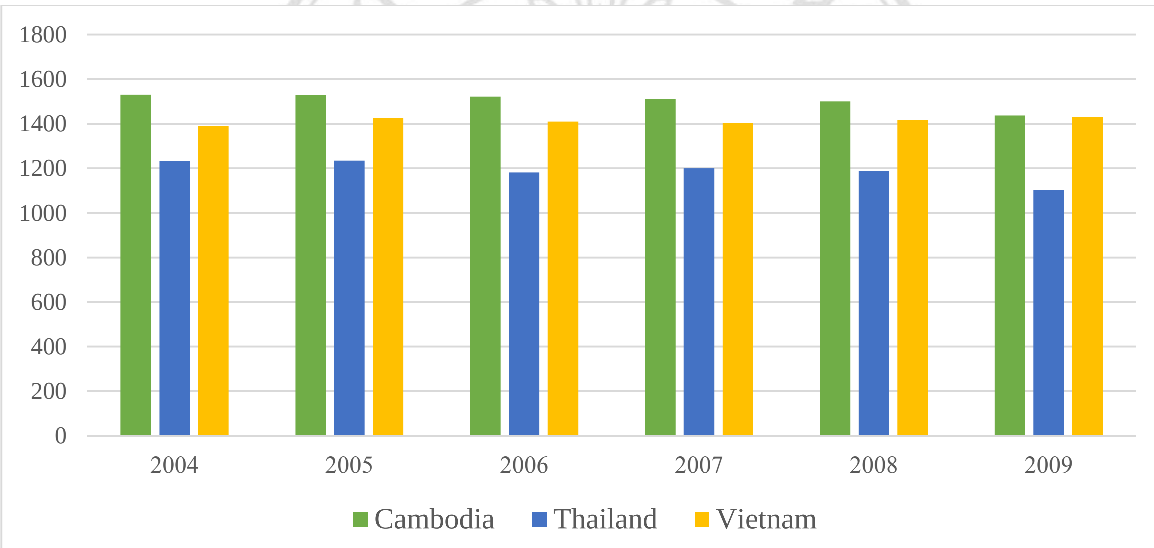


Figure 4.5: Rice Consumption Per Capita in Three Asean Countries (Kilograms per year)

Source: International Rice Research Institute (2014)

4.2.3 Firm Strategy, Structure and Rivalry

Firm strategy, structure and rivalry takes the condition in a country with regards to company structures framework i.e. how they are established, organized and the characteristics of domestic completion into consideration (Brisibe, 2010). In Cambodia, central government is responsible for registering, designing policy implications to stimulate rice production, and manage companies in rice producing industry. As Table 4.6 demonstrates that, the central government has designed various trade policy tools such as explore export opportunities in regional and global market, and enhance trade facilitation and reduce informal fees and eliminate illegal check points.

Table 4.6: Policy Measures for Production of Rice Production, Cambodia (continued)

Issues to be addressed	Policy measures
Enhance trade facilitation, reduce informal fees and eliminate illegal check points	-Develop a specific strategy to identify and streamline export processing procedures including inspection, documentation requirements, fees and time required to process export applications -Define clear and publicly transparent division of responsibilities among export regulating ministries/agencies -Consider rice export as a top priority in order to reduce to a minimum informal payments and time required to export by extending “special treatment” similar to the garment sector
Implement single-stop service for export processing	-Set up a Single Stop Service for export processing and issuing certificate for sanitary and phyto-sanitary (SPS), fumigation, grading and quality, quantity and weight, and customs declaration
Address grading and quality standards in compliance with internationally-recognized standards	-Create an independent certifying body or encourage well-known international independent certifying institutions to issue grading and quality certificates as required by importing countries -Define grading and standards of Cambodian rice and collaborate with the private sector to enforce them -Build technical capacity to achieve the required standards

Table 4.6: Policy Measures for Production of Rice Production, Cambodia

Issues to be addressed	Policy measures
Invest in necessary infrastructure to reduce the cost of export	-Prepare plan of actions to reduce infrastructure-related costs for export -Engage bilateral and multilateral partners and/or the private sector to mobilize resources for investment projects
Facilitate financing for export	-Considering the establishment of the Export-Import Bank (Exim Bank) to support the export of milled rice and other agricultural products
Explore export opportunities in regional and global markets	-Comprehensive study on Cambodia's potential markets for rice -Disseminate widely the results to stakeholders -Lead trade delegations consisting of representatives of relevant ministries and milled rice exporting companies to negotiate the sale of milled rice to the Philippines -Explore opportunities to export milled rice to Malaysia, Indonesia, Brunei, and other potential importing countries in Europe

Source: Policy Document on the Promotion of Paddy Rice Production and Export of Milled Rice, the Royal Government of Cambodia (2012)

Presently, Thailand is the world's largest exporter of rice. Thailand is the top among rice exporting countries in both value and volume, wherein rice exports are mainly long-grain and jasmine rice. Rice policies in Thailand have always been pushed domestic consumption and improving production for trade (Tobias, et al. 2012) (see Table 4.7).

Table 4.7: Rice sector policies in Thailand, 2011

Policy	Description of policy
Stock policy -Public stocks	Around 100,000 tons of rice will be released from government stocks at market prices to relieve shortage due to floods. Traders and millers possessing 15 tons of rice or more are required to reports stockpiles to the government in order to prevent unlawful pledging of stocks.
Export policy -Maximum export price	MEPs are $1,060 per ton for jasmine rice, $550-560 per ton for 5% broken rice, $535-545 per ton for 25% broken rice, and $555-565 per ton for parboiled rice.

Source: Handbook on Rice Policy for Asia, IRRI (2012)

Rice policies in Vietnam are a balance between maintaining domestic food security and promoting rice export. As Table 4.8 shows the major policies implemented in Vietnam.

Table 4.8: Rice sector policies in Vietnam, 2011

Policy	Descriptive of policy
Consumption policy -Price support	The price support for paddy is VND 5,000 per kilogram ($0.24 per kilogram).
Export policy -Minimum export price -State trading	The MEPs are $465-475 per ton for 5% broken rice and $425-435 per ton for 25% broken rice. VFA is the country's state owned enterprise. It does processing and trading of food and agricultural products, especially rice.

Source: Handbook on Rice Policy for Asia, IRRI (2012)

4.2.4 Related and Supporting Industries

The local supporting industries in Cambodia remains insufficient, the factor that can facilitate rice industry is very limited. Sum (2008) stated that approximately 50 percent of the roads are made of crushed stone, gravel, or improved earth; and the remaining 30 percent are unimproved earth or little more than tracks. As comparing the situation in Cambodia with neighboring countries like Thailand and Vietnam, infrastructure access in Cambodia is very poor (see Table 4.9).

Table 4.9: Infrastructure access in three countries, 2005

Countries	Water supply[1]	Electricity[2]	Telephone[3]	Internet[4]
Thailand	93	84	50	11.1
Vietnam	49	81	9	4.3
Cambodia	44	17	4	0.2

Source: ADB, JBIC, WB, (2005), Cited in Sum (2008)

Note: 1. Percentage of population with access to at least 20 liters per person per day from "improved" water supply from a source within one kilometer from the user's dwelling.

2. Percentage of households with electricity access through commercially sold electricity, both on-grid and off-grid.

3. Telephone subscribers per 100 inhabitants

4. Number of user per 100 inhabitants

The electricity price in Cambodia is very high. The Global Agricultural and Food Security Program reported that, electricity accounts for 25% of the total processing costs, high energy price is an obstacle to the expansion of the irrigation system. Since energy prices in Cambodia remains high, farmer households have to limit their abilities to plant two rice crops a year. For example, in 2010, urban dwellers pay approximately 18 to 20 cents. As comparing, in Vietnam the rate is at 10 cents. High electricity cost force rice millers to use their own diesel generators, which cost them only 12.60 dollars or 2.2% per ton of rice, compared to 23.38 dollars or 4.1% per ton by using electricity.

Based on government strategy (2010) (rice export policy), the lack of handling equipment in Sihanoukville Port is an obstacle for the export of large quantity of milled rice. Only vessel with depth less than 8 to 8.9 meters can dock at the Sihanoukville Port. The maximum allowable load of vessels docking in the port is 10 thousand tons suitable only for shipment of milled rice to Southeast Asia or Africa. The Ho Chi Minh Port allows vessels with load capacity up to 30 thousand tons in docking station and 60 thousand tons in transfer zone.

According to the Royal Government of Cambodia (2010) (rice export policy paper), poor transport infrastructures such as roads, railways, warehouse, and handling equipment increase rice price. As comparing, to transport one ton of rice on 100 km road, Cambodia households spend 15 dollars, which only 4 dollars and 7.5 dollars in Thailand and Vietnam respectively.

4.2.5 Government

In order to achieve paddy rice surplus of more than 4 million tons and reach the goal of exporting milled rice at least 1 million tons in 2015, Cambodian government has launched the policy on paddy rice production and promotion of milled rice export (see Table 4.10).

Table 4.10: Rice production policy in Cambodia, Thailand, and Vietnam, 2011 (continued)

Country	Description of rice production policy
Cambodia	-The government guarantees 50% of commercial bank lending to rice producers. Allocation of $310 million to improve rice irrigation systems. -Facilitate import clearance procedures for rice seeds, fertilizers, agricultural inputs and machinery. -Continue providing tax incentive to encourage imports of material and equipment.

Table 4.10: Rice production policy in Cambodia, Thailand, and Vietnam, 2011

Country	Description of rice production policy
Thailand	Price support -THB 13,800-15,000 ($446-484) per ton for white rice; THB 15,000-16,000 ($484-517 per ton) for glutinous rice; THB 16,000 ($517 per ton) for long-grain glutinous or Pathum Thani rice; THB 18,000 ($581 per ton) for provincial fragrant rice, and THB 20,000 ($646 per ton) for Hom Mali rice. -Subsidized fertilizers are available to rice farmers, for which they receive a direct subsidy of $49.97 per ton. -Rice cultivation will be restricted to two crops per year.
Vietnam	To keep the price of rice stable, VFA (Vietnam Food Association) bought 1 million tons of rice from farmers to prevent rice importers from haggling during the harvest season.

Source: Handbook on Rice Policy for Asia, IRRI (2012)

4.2.6 Chance

Agricultural productivity remain low, with the average rice yield 2.3 tons per hectare in Cambodia is about a half of that Vietnam with yield averaging barely 5 tons per hectare. Essentially, despite the lower yield and smaller rice area, rice production per capita 4.26 kg rough rice in Cambodia is not far different from Thailand and Vietnam (see Table 4.11). It means that a high level of rice production per capita has shown the potential for Cambodian rice export.

Table 4.11: Rough rice average area, yield, and production, selected ASEAN countries, 2004 - 2013

Rice[b]	Unit	Cambodia	Thailand	Vietnam
Area[b]	1000ha	2,638.90	10,647.90	7,511.90
Yield[b]	t/ha	2.26	2.77	5.24
Production[b]	1000t	6,005.90	29,561.00	39,397.20
Total population[a]	million	14,086,350	66,184,460	85,576,690
Rice production per capita[b]	kg/person	426	447	460

Source: Data from [a] World Bank (2014), [b] USDA (2014)

Many factors influence to production growth, technology is considered to be the major factor contributes to growth in rice production. The yield growth rate of Cambodia rice production increased approximately from 1.1 percent per year during 1961 – 1995 to 2.17 percent during 1996 – 2013. While Thailand decreased approximately from 1.13 percent per year during 1961 – 1995 to 0.99 percent per year during 1996 – 2014. Similarly, Vietnam increased approximately from 2.62 percent per year during 1961 – 1995 to 2.96 percent during 1996 – 2013 (see Figure 4.6). Therefore, rice production in Cambodia has potential to growth depends on technology, better-quality seeds, expansion of dry-season rice, and irrigation system, and fertilizers.

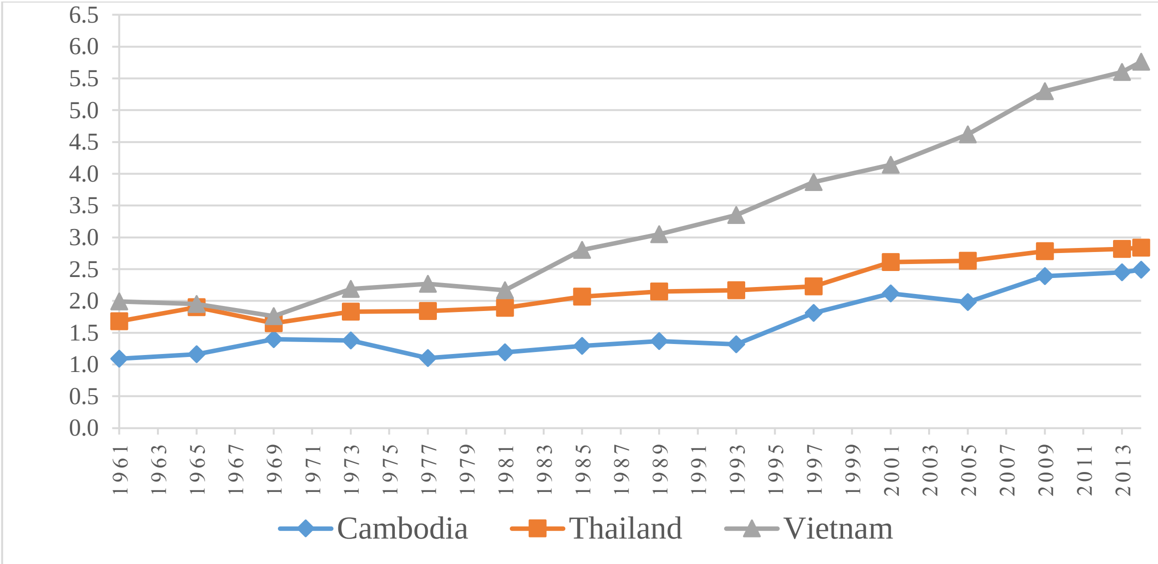


Figure 4.6: Trends in yield of rough rice, selected ASEAN countries, 1961 – 2013

Source: Data from USDA (2014)

Since 1996, the trend in rice production per capita in Cambodia is similar to Thailand and Vietnam which approximately 500kg of rough rice per capita (see Figure 4.7).

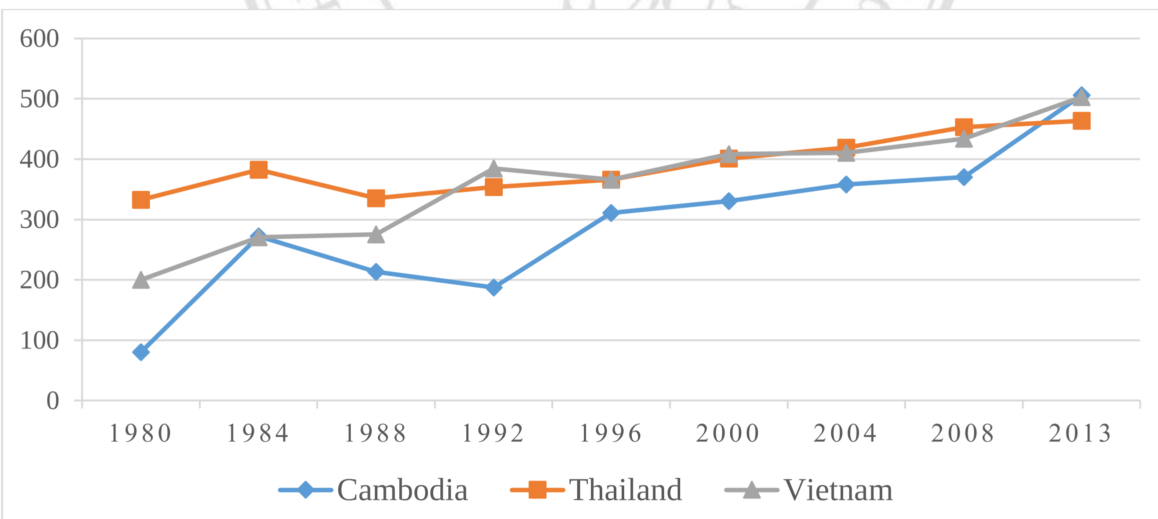


Figure 4.7: Per capita production of rough rice, seceded ASEAN countries, 1980 - 2013

Source: Data from USDA (2014)

4.3 Rice Production in Cambodia

4.3.1 Results of the Unit Root Test

This study examines the order of integration of the variables by ADF-Test (1979) and if all variables are integrated of I(0) and (1) then ARDL would be applied to co-integration for the long run relationship between the dependent variable and the independent variables Pesaran et al. (2001). Since the variables had accepted the long run co-integration, then Error Correction Model (ECM) could be applied for estimating the short-run relationship between the dependent variables and the independent variables. The results of the unit root test based on ADF-Test are demonstrated in the Table 4.12. All variables are used in the Cambodian rice production model, are both integrated of order (d) and integrated of order (0).

Table 4.12: The Results of Unit Root Test of Augmented Dickey-Fuller (ADF) at Level for Rice Production (continued)

Variable	t-ratios (p-value)	Result
Non-constant		
$LnFE_t$	-0.0615 (0.2494)	non-stationary
$LnHV_t$	0.0246 (0.9066)	non-stationary
$LnIR_t$	0.0024 (0.0122)*	stationary
$LnPR_t$	0.0016 (0.5907)	non-stationary
$LnMA_t$	-0.0213 (0.3433)	non-stationary
$LnSD_t$	0.0011 (0.6269)	non-stationary
Constant (Intercept)		
$LnFE_t$	-0.3485 (0.0033)***	stationary
$LnHV_t$	-0.1579 (0.0616)**	stationary

Table 4.12: The Results of Unit Root Test of Augmented Dickey-Fuller (ADF) at Level for Rice Production

Variable	t-ratios (p-value)	Result
$LnIR_t$	-0.0242 (0.1999)	non-stationary
$LnPR_t$	-0.0875 (0.2394)	non-stationary
$LnMA_t$	-4.4594 (0.0005)***	stationary
$LnSD_t$	-0.0641 (0.3606)	non-stationary
Constant and Trend		
$LnFE_t$	-0.3639 (0.0025)***	stationary
$LnHV_t$	-0.1912 (0.0285)*	stationary
$LnIR_t$	-0.1536 (0.0528)*	stationary
$LnPR_t$	-0.1964 (0.0298)*	stationary
$LnMA_t$	-7.0443 (0.0004)***	stationary
$LnSD_t$	-0.1329 (0.8080)	non-stationary

Source: computed, *=Significant at 10%, **=Significant at 5%, ***=Significant at 1%

Since first differencing in all variable (excepted the variables have integrated of order I(0)) would be used in the model as well as the integrated of order in all variables changed. The results of unit root test after first differencing had been shown in Table 4.13.

Table 4.13: The Results of Unit Root Test of Augmented Dickey-Fuller (ADF) at the 1st for Rice Production (continued)

Variable	t-ratios (p-value)	Result
Non-constant		
$LnFE_t$	-0.9723 (0.0000)***	stationary
$LnHV_t$	-1.1603 (0.0000)***	stationary
$LnIR_t$	-0.5355 (0.0026)***	stationary
$LnPR_t$	-1.2666 (0.0000)***	stationary
$LnMA_t$	-8.4412 (0.1077)*	stationary
$LnSD_t$	-0.9933 (0.0000)***	stationary
Constant (Intercept)		
$LnFE_t$	-0.9727 (0.0000)***	stationary
$LnHV_t$	-1.1607 (0.0000)***	stationary
$LnIR_t$	-0.8477 (0.0000)***	stationary
$LnPR_t$	-1.2762 (0.0000)***	stationary
$LnMA_t$	-4.4594 (0.0005)***	stationary
$LnSD_t$	-8.2535 (0.2058)	non-stationary
Constant and Trend		
$LnFE_t$	0.1486 (0.0000)***	stationary
$LnHV_t$	-1.1803 (0.0000)***	stationary
$LnIR_t$	-0.8596 (0.0000)***	stationary

Table 4.13: The Results of Unit Root Test of Augmented Dickey-Fuller (ADF) at the 1st for Rice Production

Variable	t-ratios (p-value)	Result
$LnPR_t$	-1.2975 (0.0000)***	stationary
$LnMA_t$	-16.8479 (0.0291)***	stationary
$LnSD_t$	-1.04384 (0.0000)***	stationary

Source: computed, *=Significant at 10%, **=Significant at 5%, ***=Significant at 1%

After the first differencing in all variables were used in Cambodian rice production model. It found that all variables were integrated of order d(1).

4.3.2 The Results of the Co-integration Test of Cambodian Rice Production as in a Long-run based on ARDL approach

F-statistics for testing the existence of the long run relationship among variables of Cambodian rice production model. And the critical value bounds of the F-statistics with intercept and no trend (K=5) from Pesaran and Shin (2001). For all the variable in Cambodian rice production model, F-statistics is higher than the upper bound critical value at the 1% level. This implies that the null hypothesis of no co-integration can be rejected and there is co-integration relationship among the variables for the model.

Table: 4.14: F-statistics for testing the existence of the long-run relationship among variable and critical value bounds of the F-statistics with intercept and no trend (k=5) from Pesaran and Shin (2001).

Depend variable (intercept and no trend)	F-statistics	1% Critical value		The number of k
		I(0) Lower bound	I(1) Upper bond	
F_t ($LnPR_t$| $LnFE_t$, $LnHV_t$, $LnIR_t$, $LnMA_t$, $LnSD_t$)	13.165***	2.649	3.805	5

Source: computed, *=Significant at 10%, **=Significant at 5%, ***=Significant at 1

Table: 4.15: Estimated ARDL long run coefficients for rice production in Cambodia from Pesaran and Shin (2001) (continued)

Regressor	Coefficient	t-ratio (p-value)
$LnFE_{t-1}$	-0.008	-0.78 (0.437)
$LnFE_{t-2}$	0.011	1.06 (0.297)
$LnFE_{t-3}$	8.920	0.07 (0.993)
$LnFE_{t-4}$	-0.030	-2.55 (0.016)***
$LnFE_{t-5}$	0.026	2.71 (0.011)***
$LnHV_{t-1}$	-0.382	-1.72 (0.094)*
$LnHV_{t-2}$	0.297	2.36 (0.024)**
$LnIR_{t-1}$	0.152	1.79 (0.083)*
$LnMA_{t-1}$	-0.001	-0.14 (0.885)
$LnMA_{t-2}$	-0.246	-0.50 (0.614)

Table: 4.15: Estimated ARDL long run coefficients for rice production in Cambodia from Pesaran and Shin (2001)

Regressor	Coefficient	t-ratio (p-value)
$LnMA_{t-3}$	1.143	1.73 (0.093)*
$LnMA_{t-4}$	-1.015	-2. 46 (0.019)**
$LnSD_{t-1}$	1.355	9.60 (000)***
$LnSD_{t-2}$	-0.781	3.22 (0.003)***

Source: computed, *=Significant at 10%, **=Significant at 5%, ***=Significant at 1%

4.3.3 The results of the analysis of Cambodian rice production as in a long-run based on ARDL approach to co-integration

The empirical results of the long-run for Cambodian rice production are presented on the Table 4.15. All variables appeared with both the correct sign and incorrect sign. Precisely, fertilizers, irrigations, machinery (tractors), harvested area, and seed of Cambodia are influential in Cambodian rice production. Consequently, all variables were used in this study impact on the Cambodian rice production during 1961-2010. According to ARDL approach to co-integration, suggested that ln(SDt), ln(HVt), ln(FEt) and ln(MA) have negatively and positively impacted on Cambodian rice production based on the number of lags and ln(IRt) has positively impacted Cambodian rice production. The empirical results imply that in long-run when ln(IR_t) increases 1% then the Cambodian rice production increases 0.15% and when ln(SD_t) increases 1% and then the Cambodian rice production increases 1.35% at lag 1 and decreases 0.78% at lag 2. The empirical results also indicate that in long-run when ln(FE) increases 1% then the Cambodian rice production decreases 0.03% at lag 4 and then starts to increase 0.02% at lag 5. Similarly, when ln(HV_t) increases 1% then the Cambodian rice production decreases 0.38% at lag 1 and then starts to increase 0.29% at lag 2. Furthermore, when ln(MAt) increases 1% then cause Cambodian rice production increases 1.14% at lag 3 and then decreases 1.01 at lag 4.

4.3.4: The results of the long-run relationship in Cambodian rice production as in short-run (ECM) selected based on ARDL approach to co-integration

The results of the error correction model for Cambodian rice production is presented in Table 4.16. ECM model was selected by ARDL approach to co-integration. This approach was developed by Pesaran and Pesaran (1997), Pesaran and Smith (1998) and Pesaran et al. (1997).

The empirical results in the short-run revealed that seeds have positively impacted on Cambodian rice production. The results demonstrated that in short-run when seeds increasing 1% then Cambodian rice production increasing 1.1701%. Otherwise, when irrigation increasing 1% then Cambodian rice production decreasing 0.6719%.

Table 4.16: The results of the short-run relationship in Cambodian rice production based on error correction model selected by ARDL approach to co-integration (continued)

Variables	Coefficient
C	0.0428 (0.5244)
Δln(FE)	0.0010 (0.1247)
Δln(IR)	-0.6719* [a] (-1.8812)
Δln(MA)	0.0017 (0.1644)

Table 4.16: The results of the short-run relationship in Cambodian rice production based on error correction model selected by ARDL approach to co-integration

Variables	Coefficient
$\Delta \ln(SD)$	1.1701*** [a] (9.7139)
$\Delta \ln(HV)$	0.4554 (0.1673)
EC_{t-1}	-0.5424*** (-2.7743)
R^2	0.7561
$\bar{R}^2$	0.7123
DW.	1.7646
F-statistics	17.2720***

Source: computed, a=lag 1 period, * = Significant at 10%, ** = Significant at 5%, *** = Significant at 1%

The lagged error correction term EC_{t-1} is negative and significant at the 1% level. The coefficient of 0.5424 indicated a moderate rate of convergence to equilibrium. The value of adjusted R^2 of ECM model is more than 70%. The value of F-statistics indicated that Cambodian rice production ECM model is fit for a short-run by statistically significant at 1%.

4.4 Rice Production on Cambodian Economic Growth

4.4.1 Results of the Unit Root Test

This study examines the order of integration of the variables by ADF-Test (1979) and if all variables are integrated of I(0) and (1) then ARDL applied to co-integration for the long run relationship between the dependent variable and the independent variables Pesaran et al. (2001). Since the variables had accepted the long run co-integration, then Error Correction Model (ECM) applied for estimating the short-run relationship between the dependent variables and the independent variables. The results of the unit root test based on ADF-Test are demonstrated in the Table 4.17. All variables are used in contribution of rice production and export to Cambodian economic growth, are integrated of order (d).

Table 4.17: The Results of Unit Root Test of Augmented Dickey-Fuller (ADF) at Level for Rice Production on Economic Growth (continued)

Variable	t-ratios (p-value)	Result
Non-constant		
$LnRGD_t$	2.0270 (0.9839)	non-stationary
$LnGFC_t$	3.7751 (0.9995)	non-stationary
$LnEXP_t$	0.9701 (0.9021)	non-stationary
$LnLAB_t$	0.7503 (0.8646)	non-stationary
Constant (Intercept)		
$LnRGD_t$	-0.6172 (0.8369)	non-stationary
$LnGFC_t$	-1.4574 (0.5245)	non-stationary
$LnEXP_t$	-0.3875 (0.8866)	non-stationary
$LnLAB_t$	-0.6465 (0.8296)	non-stationary
Constant and Trend		
$LnRGD_t$	-2.0728 (0.5154)	non-stationary
$LnGFC_t$	-2.0322 (0.5353)	non-stationary

Table 4.17: The Results of Unit Root Test of Augmented Dickey-Fuller (ADF) at Level for Rice Production on Economic Growth

Variable	t-ratios (p-value)	Result
$LnEXP_t$	-2.0728 (0.5154)	non-stationary
$LnLAB_t$	-1.9988 (0.5522)	non-stationary

Source: computed

Since first differencing in all variable (excepted the variables have integrated of order I(0)) would be used in the model as well as the integrated of order in all variables changed. The results of unit root test after first differencing had been shown in Table 4.18.

Table 4.18: The Results of Unit Root Test of Augmented Dickey-Fuller (ADF) at the 1^{st} for Rice export on Economic Growth (continued)

Variable	t-ratios (p-value)	Result
Non-constant		
$LnRGD_t$	-0.7054 (0.3915)	non-stationary
$LnGFC_t$	-1.3017 (0.1669)	non-stationary
$LnEXP_t$	-4.0903 (0.0006)***	stationary
$LnLAB_t$	-3.5439 (0.0019)***	stationary
Constant (Intercept)		
$LnRGD_t$	-1.9257 (0.3101)	non-stationary
$LnGFC_t$	-3.9955 (0.0111)***	stationary
$LnEXP_t$	-4.2983 (0.0066)***	stationary
$LnLAB_t$	-3.6943 (0.0187)***	stationary

Table 4.18: The Results of Unit Root Test of Augmented Dickey-Fuller (ADF) at the 1st for Rice export on Economic Growth

Variable	t-ratios (p-value)	Result
Constant and Trend		
$LnRGD_t$	-2.2635 (0.4218)	non-stationary
$LnGFC_t$	-4.2800 (0.0252)**	stationary
$LnEXP_t$	-4.9101 (0.009)***	stationary
$LnLAB_t$	-3.6110 (0.0694)*	stationary

Source: computed,* = Significant at 10%, ** = Significant at 5%, *** = Significant at 1%

After the first differencing in all variables were used in Cambodian rice production model. It found that all variables were integrated of order d(1).

4.4.2 The Results of the Co-integration Test of Cambodian Rice export on Economic Growth as in a Long-run based on ARDL approach

F-statistics for testing the existence of the long run relationship among variables of Cambodian rice export model. And the critical value bounds of the F-statistics with no intercept and no trend (K=3) from Pesaran and Shin (2001). For all the variable in Cambodian rice export contributions on economic growth model, p-value is significantly statistical at the 10% level. This implies that the null hypothesis of no co-integration can be rejected and there is co-integration relationship among the variables for the model.

Table: 4.19: F-statistics for testing the existence of the long-run relationship among variable and critical value bounds of the t-ratios (p-value) with no intercept and no trend (k=3) from Pesaran and Shin (2001).

Depend variable (intercept and no trend)	F-statistics	10% Critical value		The number of k
		I(0) Lower bound	I(1) Upper bond	
F_t ($LnRGD_t$| $LnGCF_t$, $LnEXP_t$)	0.100*	2.649	3.805	3

Source: computed, *=Significant at 10%, **=Significant at 5%, ***=Significant at 1%

Table: 4.20: Estimated ARDL long run coefficients and short run for Cambodian rice export on economic growth from Pesaran and Shin (2001).

Regressor	Coefficient	t-ratio (p-value)
$LnRGD_{t-1}$	0.966	32.21 (0.000)***
$LnGFC_{t-1}$	0.055	1.51 (0.100)*
$LnEXP_{t-1}$	-0.017	-1.56 (0.100)*
$LnLAB_{t-1}$	-0.006	-1.82 (0.0981)*

Source: computed, *=Significant at 10%, **=Significant at 5%, ***=Significant at 1%

4.4.3 The results of the analysis of Cambodian Rice export on Economic Growth as in a long-run based on ARDL approach

The empirical results of the long-run for Cambodian rice export contributions on economic growth are presented on the Table 4.20. All variables appeared with both the correct sign and incorrect sign. Precisely, gross fixed capital, rice export and agricultural labor force of Cambodia are influential in Cambodian economic growth. Consequently, all variables were used in this study impact on the Cambodian economic growth during 1996-

2011. According to ARDL approach to co-integration, suggested that $\ln(LAB_t)$ and $\ln(EXP_t)$ have negatively impacted on Cambodian economic growth. On the other hand, $\ln(GFC_t)$ has positively impacted on economic growth. The empirical results imply that in long-run when $\ln(GFC_t)$ increases 1% then the Cambodian real GDP growth 0.05%. In contrast, when $\ln(EXP_t)$ and $\ln(LAB_t)$ increases 1% and then the Cambodian real GDP growth decreases 0.01% and 0.006% respectively.

4.4.4: The results of the long-run relationship in Cambodian rice export as in short-run (ECM) selected based on ARDL approach to co-integration

The results of the error correction model for Cambodian rice export is presented in Table 4.21. ECM model was selected by ARDL approach to co-integration. This approach was developed by Pesaran and Pesaran (1997), Pesaran and Smith (1998) and Pesaran et al. (1997).

The empirical results in the short-run revealed that rice export has no positively impacted on Cambodian real GDP growth.

Table 4.21: The results of the short-run relationship in Cambodian rice export based on error correction model selected by ARDL approach to co-integration (continued)

Variables	Coefficient
$\Delta\ln(EXP_t)$	-0.0204** [a] (-2.4976)
$\Delta\ln(GFC_t)$	0.0789 (1.1328)
$\Delta\ln(LAB_t)$	0.0006 (0.1690)

Table 4.21: The results of the short-run relationship in Cambodian rice export based on error correction model selected by ARDL approach to co-integration

Variables	Coefficient
EC_{t-1}	-1.17*** [a] (-2.0372)
R^2	0.60
$\bar{R}^2$	0.40
DW.	2.3157

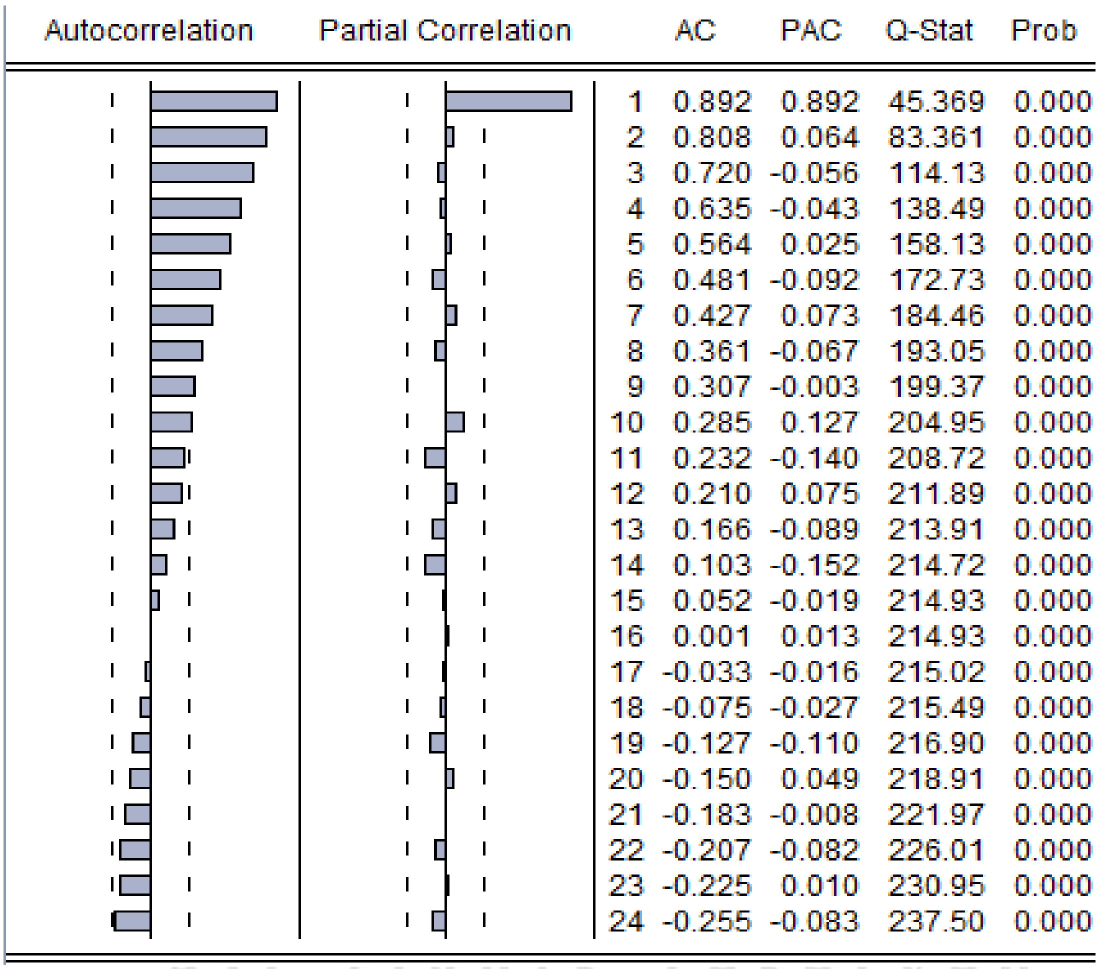
Source: computed, a=lag 1 period, * = Significant at 10%, ** = Significant at 5%, *** = Significant at 1%

The lagged error correction term EC_{t-1} is negative and significant at the 1% level. The coefficient of 1.17% indicated a moderate rate of convergence to equilibrium is greater than -1 which means there is no short-run relationship among dependent variable and independent variables. The value of adjusted R^2 of ECM model is less than 70%.

4.5 Rice Production Forecasting Model

4.5.1 Model Identification

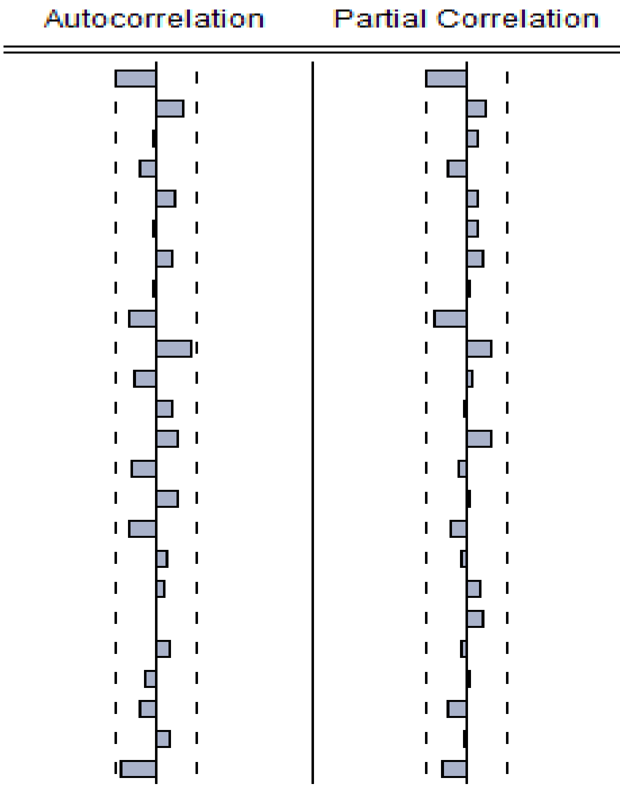
Autoregressive Moving Average (ARIMA) model was estimated after converting variables to be stationary. Autocorrelation function (ACF) is very common method to check whether a time series is stationary or not. ACF and partial auto correlation function are employed to judge auto-regression and moving average orders of the models. The autocorrelation function and partial autocorrelation function of rice production in Cambodia are employed. Figure 4.8 indicated that the ACF decreases very slowly and statistically different from zero; PACF declines dramatically and statistically insignificant. It is indicated that time series are non-stationary. It is necessary to take the first difference of time series in order to convert data to be stationary. The autocorrelation function of first differenced time series of rice production in Cambodia is presented in Figure 4.9. The first differenced time series demonstrates that the autocorrelation decreases rapidly. It is shown that the first differenced time series are stationary. The corellogram of the partial autocorrelation, cuts off close to zero after lag 1 so that “p” should be decided to be 1 and 2. ACF of the corellogram of rice production indicated that the auto correlation function declines after lag 2, therefore q values are considered to be 1 and 2.



Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.892	0.892	45.369	0.000
		2	0.808	0.064	83.361	0.000
		3	0.720	-0.056	114.13	0.000
		4	0.635	-0.043	138.49	0.000
		5	0.564	0.025	158.13	0.000
		6	0.481	-0.092	172.73	0.000
		7	0.427	0.073	184.46	0.000
		8	0.361	-0.067	193.05	0.000
		9	0.307	-0.003	199.37	0.000
		10	0.285	0.127	204.95	0.000
		11	0.232	-0.140	208.72	0.000
		12	0.210	0.075	211.89	0.000
		13	0.166	-0.089	213.91	0.000
		14	0.103	-0.152	214.72	0.000
		15	0.052	-0.019	214.93	0.000
		16	0.001	0.013	214.93	0.000
		17	-0.033	-0.016	215.02	0.000
		18	-0.075	-0.027	215.49	0.000
		19	-0.127	-0.110	216.90	0.000
		20	-0.150	0.049	218.91	0.000
		21	-0.183	-0.008	221.97	0.000
		22	-0.207	-0.082	226.01	0.000
		23	-0.225	0.010	230.95	0.000
		24	-0.255	-0.083	237.50	0.000

Figure 4.8: The first difference of Autocorrelation and Partial Autocorrelation Correlogram of rice production

Source: computed



	AC	PAC	Q-Stat	Prob
1	-0.272	-0.272	4.1502	0.042
2	0.186	0.121	6.1281	0.047
3	-0.008	0.076	6.1320	0.105
4	-0.102	-0.121	6.7551	0.149
5	0.125	0.068	7.7076	0.173
6	-0.019	0.072	7.7296	0.259
7	0.106	0.099	8.4357	0.296
8	-0.013	0.009	8.4466	0.391
9	-0.181	-0.220	10.610	0.303
10	0.235	0.168	14.361	0.157
11	-0.145	0.032	15.814	0.148
12	0.100	-0.022	16.522	0.168
13	0.150	0.170	18.164	0.151
14	-0.165	-0.064	20.200	0.124
15	0.135	0.011	21.588	0.119
16	-0.183	-0.100	24.216	0.085
17	0.070	-0.041	24.609	0.104
18	0.061	0.093	24.916	0.127
19	0.002	0.100	24.917	0.163
20	0.091	-0.026	25.645	0.178
21	-0.071	0.019	26.098	0.203
22	-0.108	-0.132	27.204	0.204
23	0.085	-0.017	27.904	0.219
24	-0.234	-0.167	33.415	0.096

Figure 4.9: The first difference of Autocorrelation and Partial Autocorrelation Correlogram of rice production

4.5.2 Model Estimation

Four ARIMA models were used to select the best model which has the minimum AIC (Akaike's Information Criterion), SBC (Schwarz's Bayesian Criterion), MSE (Mean Square Error), RMSE (Root Mean Square Error), and MAPE (Mean Absolute Percentage Error) and maximum values of R^2 and $\bar{R}^2$. They are ARIMA (1, 1, 1), ARIMA (1, 1, 2), ARIMA (2, 1, 1), and ARIMA (2, 1, 2)

Table 4.22: Comparison of different ARIMA models with model fit statistics for rice production

Model	Value of selection criteria						
	MSE	MAPE	RMSE	AIC	SBC	R^2	$\overline{R}^2$
ARIMA (1, 1, 1)	**247820.1**	**19.08**	323967.7	**28.32**	**28.43**	**0.91**	**0.91**
ARIMA (1, 1, 2)	**247820.1**	19.45	**320632.1**	28.34	28.49	0.91	0.91
ARIMA (2, 1, 1)	251248.8	19.81	323365.4	28.36	28.51	0.91	0.91
ARIMA (2, 1, 2)	253737.3	19.75	322140.0	28.39	28.58	0.91	0.90

Source: computed.

4.5.3 Model Diagnostic Checking

Diagnostic checking of the models to check if they are white noise as the results of residual plots of ACF and PACF are presented in Figure 4.13. It is shown that the independence of random shocks is obviously not rejected even at 24 lags with p-value of 0.471. It can be concluded that all residual autocorrelation of ACF and PACF estimates are within 95% confidence intervals and confirmed confidence bound the model which ensures that the residuals are white noise. Therefore, ARIMA (1, 1, 1) model is the best appropriate model for selecting to forecast rice production in Cambodia.

Table 4.23: Estimated Results of Rice Production from ARIMA (1, 1, 1)

Variable	**Coefficient**	**SD**	**t-ratio (P-value)**
AR (1)	1.0421	0.0350	29.7139***
MA (1)	-0.2774	0.1434	-1.9159*
R^2	0.91		

Source: computed, * = Significant at 10%, ** = Significant at 5%, *** = Significant at 1%

Based on the results of time series of rice production (Y_t), it is indicated that ARIMA (1, 1, 1) is the best fitted model. The estimated parameters of mathematical model can be written as follows:

$$Y_t = 1.042105\, Z_{t-1} + \varepsilon_t - 0.274874\varepsilon_{t-1}$$

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.034	-0.034	0.0633	
		2	0.145	0.144	1.2655	
		3	-0.043	-0.034	1.3718	0.241
		4	-0.138	-0.165	2.5114	0.285
		5	0.059	0.065	2.7230	0.436
		6	-0.009	0.042	2.7277	0.604
		7	0.068	0.037	3.0172	0.697
		8	-0.067	-0.093	3.3086	0.769
		9	-0.181	-0.195	5.4896	0.600
		10	0.150	0.191	7.0075	0.536
		11	-0.101	-0.024	7.7086	0.564
		12	0.098	-0.012	8.3881	0.591
		13	0.134	0.135	9.7040	0.557
		14	-0.139	-0.112	11.147	0.516
		15	0.055	0.003	11.377	0.579
		16	-0.175	-0.107	13.780	0.466
		17	0.043	0.007	13.927	0.531
		18	0.082	0.121	14.485	0.563
		19	0.059	0.086	14.788	0.611
		20	0.096	-0.028	15.601	0.620
		21	-0.075	-0.002	16.112	0.650
		22	-0.128	-0.135	17.651	0.610
		23	0.007	-0.015	17.655	0.671
		24	-0.204	-0.155	21.821	0.471

Figure 4.10: Residual plots of ACF and PACF of rice production

4.5.4 Historical Forecasting

Historical forecasting of rice production in Cambodia, rice production is estimated using the best selected model. As Figure 4.14 shown that the forecasting values of rice production in Cambodia during the period of time 1960-2013 is similar to the actual values of rice production. It is concluded that ARMA (1, 1, 1) is the best fit forecasting model of rice production in Cambodia.

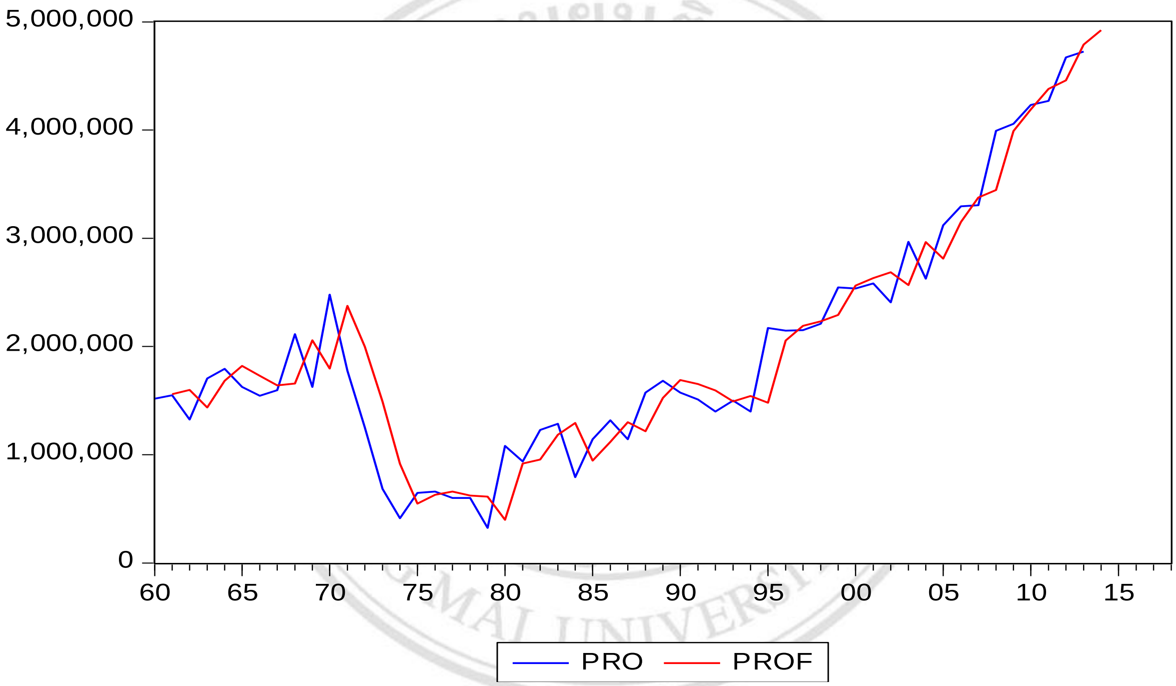


Figure 4.11: Actual and Forecasting Values

Source: Computed.