ECONOMIC AND FINANCIAL ANALYSIS

A. Introduction

1. The economic analysis of the project was undertaken according to Asian Development Bank guidelines and describes the economic rationale for public intervention. The analysis quantifies the benefits and costs of the investment for the construction of small dams and weirs in economic terms and measures the net worth of the project to the country. Financial values are converted to economic values by removing the effects of government intervention and market distortions. An economic surplus analysis framework is used to estimate the project impacts on consumers and producers of agriculture commodities. A benefit–cost analysis is undertaken to measure the key investment criteria of economic internal rate of return (EIRR) and economic net present value (ENPV).

2. Two scenarios are compared to determine the economic net benefits of the project: the without-project scenario and the with-project scenario. The without-project scenario assumes a continuation of current production activities, which is a combination of dryland wheat production and intermittent irrigation of wheat and maize crops in *barani* (dryland) areas with low agriculture productivity. The with-project scenario assumes a transition to more intensive irrigation with an associated increase in crop intensities and crop yields, and a shift toward the production of high-value vegetable crops. Hence, a primary benefit of the project will be an increase in agriculture productivity. There will also be a reduction in downstream flood losses following the construction of small dams. Considerable uncertainty surrounds the values of key variables that influence the project benefit, including (i) capital costs, (ii) the impact of security conditions and potential delays in project benefits, (iii) improvements in crop yields, (iv) increased crop intensity, and (v) the adoption rate of high-value vegetable crops. These are specified as random variables in a risk modelling framework.

B. Macroeconomic Assessment

3. Pakistan has shown progress on both gross domestic product (GDP) and poverty rates from 2005 to 2012.. Annual real GDP increased from $110 billion in 2005 to $138 billion in 2012.[1] The ratio of value added in the agriculture sector to GDP slightly increased from 22.2% in 2004 to 24.4% in 2012.[2] Employment in the agriculture sector was 44.7% of total employment in 2008 (footnote 1). The poverty rate in 2006 was 22.3% (13.1% in urban areas and 27.0% in rural areas) and by 2011 was 12.4%.[3] The agriculture sector is important for the Pakistan economy in terms of both outputs and employment. To reduce poverty in Pakistan it is important to sustain agriculture productivity and secure employment in agriculture.

C. Demand Analysis

4. The project area is water scarce and there is a strong demand by farmers for additional irrigation water to improve agriculture production and livelihoods. However, water is an input into crop production and the primary demand is for the commodity outputs (e.g., wheat, maize, and vegetables) by consumers.

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[1] The World Bank. *World Development Indicators*. http://data.worldbank.org/country/pakistan. 2014.
[2] Calculation by Asian Development Bank staff based on data available on World Development Indicators.
[3] The poverty rate is reflected by the poverty headcount ratio, defined as the proportion of the population that lives below the poverty line.

5. Although the Pakistan agriculture sector produces sufficient food to meet the demands of the population, there are significant geographic disparities. Food production is largely dependent on Punjab Province, which produces significant agriculture surpluses. However, most Pakistan districts are characterized as in deficit in terms of food production self-sufficiency, and FATA is characterized as in extreme deficit. FATA is highly food insecure, as shown by the following key measures: (i) 70% of the population has a caloric intake of 2,100 kilocalories (kcal) per person per day (less than 2,100 kcal is deemed inadequate), (ii) FATA has a mean caloric intake of less than 1,800 kcal per person per day, and (iii) FATA has one of the lowest protein intakes in Pakistan with less than 45% of the population rated as non-protein deficient.[4] Given the limited agriculture production and food insecurity status of FATA, there is strong local demand (particularly for vegetables) for the additional agriculture production generated by the project.

D. Rationale

6. To meet future water requirements and improve agriculture productivity in the project area, it is important to invest in irrigation infrastructure. This is unlikely to be provided by the private sector given the large capital costs and limited potential commercial returns. The project is further justified on the basis of addressing a market failure through provision of a public good through the flood control provided by dams. These benefits are nonexcludable and nonrival in nature. Flood control in the area is important to agriculture productivity but it is unlikely to be provided by the private sector.

E. Project Alternatives

7. The evaluation considered several dam and weir subprojects, which were ranked on the basis of technical efficiency. A total of 49 subprojects were identified: (i) 22 in Bajaur agency (0 dams, 22 weirs); (ii) 15 in Mohmand agency (9 dams, 6 weirs); and 12 in Khyber agency (9 dams, 3 weirs). Of these 40 subprojects, 9 dams and 31 weirs were selected for the project.

F. Methodology

1. Economic Surplus

8. An economic surplus model is used to measure the agriculture benefits of the project. As a result of a project intervention, changes in the quantity of a commodity (e.g., wheat, maize) can result in product price changes, which together leads to changes in economic welfare. Economic surplus consists of two elements, consumers' surplus and producers' surplus. Consumers' surplus is defined as the extra amount a consumer would have been prepared to pay, and is measured as the area below the demand curve and above the price line. The basic premise of consumers' surplus is that at a certain market price there are some consumers who would be willing to pay a higher price to obtain the same quantity, and their welfare is increased by obtaining the product at a lower price. The traditional measure of producers' surplus is the area above the product supply curve and below the price line. This area represents the difference between what a producer actually receives for a sale and the minimum amount he would have been prepared to accept.

9. The standard economic surplus model is used to measure the impact of a rightward shift in commodity supply functions resulting from increased agriculture production from additional

[4] Government of Pakistan, Ministry of National Food Security and Research. Draft Report on Food Security Pakistan 2012–2013.

irrigation water supplied from small dams and weirs. This will have consumer and producer effects both within the project area (Region A) and the rest of Pakistan (Region B). In Region A, there will be a direct effect on producers through the increase in supply of a commodity. Assuming competitive conditions prevail, this will also have broader implications on the rest of the country through the reduced market price as a result of increased supply. This will impact upon consumers (who gain) and producers (who lose) from the reduced market price.

2. Benefit Estimation

10. The main project benefit is increased agriculture production from additional irrigation water provided by construction of small dams and weirs. This is a function of increased crop intensity, improved crop yields, and the introduction of high-value vegetable crops (Table 1). Currently, land is cultivated with conventional low-yielding and low-value crops, predominantly wheat (*rabi* season) and maize (*kharif* season).[5] Wheat production is a combination of *barani* wheat and low-input irrigated wheat from uncontrolled water supply sources, which has relatively low yield because of intermittent irrigation.

Table 1: Crop Area, Intensity, Yields, and Production with and without Project

	Without Project			With Project		
Item	**Bajaur**	**Mohmand**	**Khyber**	**Bajaur**	**Mohmand**	**Khyber**
Crop intensity (%)						
Rabi	66	75	44	92	92	91
Kharif	14	23	14	73	63	61
Total	**79**	**97**	**57**	**165**	**155**	**152**
Crop yield (kg/ha)						
Barani wheat	619	1,104	888	619	1,104	888
Irrigated wheat	1,224	1,840	1,767	2,460	3,285	3,156
Irrigated maize	1,356	1,386	1,710	2,423	2,476	2,864
Irrigated vegetables	0	0	0	7,786	10,680	10,073
Area (ha)						
Command area	2,817	720	754	2,817	720	754
Rabi barani	1,428	428	215	0	0	0
Rabi irrigated	423	108	113	2,600	500	518
Kharif irrigated	383	164	103	1,535	338	345
Total irrigated	**806**	**272**	**216**	**4,135**	**838**	**863**
Production (tons)						
Wheat	1,401	672	390	6,943	1,782	1,775
Maize	520	228	518	2,819	500	570
Vegetables	0	0	0	3,917	1,766	1,769

ha = hectare; kg = kilogram.
Source: Asian Development Bank estimates.

11. The command area of the targeted project areas remains constant in the without-project and with-project scenarios. In the rabi season, the project impact is to switch wheat production from *barani* and low-input irrigation to high-input, higher-yield irrigated wheat. Wheat is used as a representative crop for all *rabi* crops. In the *kharif* season, there is a switch from low-input irrigated maize (representative of *kharif* crops) to high-input irrigated maize and vegetables.

12. Flood mitigation benefits are expected from the construction of dams in Khyber and Mohmand agencies (no flood benefits are considered in Bajaur agency). Following heavy rains

[5] Rabi crops are sown in winter and harvested in late winter or during early summer, and *kharif* crops are sown in summer and harvested in late summer or early winter.

(usually in July and August) flash flooding results in livestock losses, and damage to crops and infrastructure. Having capacity to store water following rains in these months will significantly reduce the potential for economic losses from floods. The financial costs associated for the 2010 floods were taken as the flood damages against a 100-year return period. These costs were estimated by the FATA Disaster Management Authority as PRs1,191 million in Khyber Agency and PRs331 million in Mohmand Agency. These included damage to agriculture, livestock, housing, roads, electricity, education, fisheries, forests, and human losses. There were additional nonquantified indirect damages (e.g., diseases and waterlogging), which are assumed to be 20% of the recorded damage values.

13. The construction of the nine dams in Khyber and Mohmand agencies is assumed to reduce flood losses by 60%. The financial flood cost was converted to an economic value using the standard conversion factor (SCF) and applying this to a 100-year return period and using a Gumbel distribution derived an average annual flood benefit of PRs70.13 million.

14. The improved watershed management output will be achieved through revegetation of selected parts of the watershed to minimize soil erosion and siltation of the dams and weirs. This will improve the sustainability of the project investment by maintaining the economic life of the infrastructure, and reduce the need for higher maintenance costs (e.g., dredging), which may not be possible to undertake in the region. However, it will also generate additional income for communities as the plantations can be periodically harvested for logs and firewood without destroying them, as natural regeneration occurs following harvest. The forested area is 5,050 hectares (ha) and is a mix of eucalyptus (25%) and acacia (75%). The economic value of timber is estimated at PRs49,680/ha for eucalyptus (total 1,263 ha) and PRs294,400/ha for acacia (total 3,788 ha). Eucalyptus is harvested every 5 years and acacia every 10 years, and these economic values are accordingly included in the benefit–cost analysis.

15. A Monte Carlo simulation model was developed and solved to estimate the EIRR and ENPV associated with the project.

16. Border prices of tradable commodities for wheat and maize were computed on the basis of latest available World Bank commodity forecasts. The exchange rate used was PRs100 to $1.00. A 30-year period was used for the benefit–cost analysis, and a discount rate of 12% was applied. The SCF represents the ratio of prices of all goods within the economy with respective international prices. The SCF was approximated by the weighted average of import and export tariffs, with subsidies excluded. The value used for the SCF was 0.92.

17. The total command areas for the subprojects in each agency are 2,817 ha for Bajaur, 754 ha for Khyber, and 720 ha for Mohmand. Yields were derived from averages based on agency statistics for *barani* and irrigated crops. Crop yields were also compared with demonstration plot yields and found to be conservative and within the range of demonstration plot data.

18. A triangular probability distribution was used for key random parameters: (i) capital cost (0%–10% increase around estimate), (ii) delay in project benefits due to deteriorating security conditions (0–4 year delay), (iii) crop yields (30% decrease to 10% increase around estimate), (iv) crop intensity (0%–30% less than the estimate), and (iv) and the proportion of vegetable crops sown in *kharif* season (0%–50% less than the estimate).

19. Capital costs: The base project financial cost was estimated as PRs5,031 million. This was comprised of investment cost (PRs3,695 million), recurrent costs (PRs394 million),

contingencies (PRs802 million), and financing charges (PRs140 million). The financial costs were converted to a total economic project cost of PRs4,090 million.

20. Recurrent costs: The annual operation and maintenance cost were estimated to be PRs7.89 million.

21. Poverty impact: Pakistan census data for 2005 was used to determine the percentage of the population as being extremely poor (income less than $1.25/day), poor (income less than $2.00/day), and nonpoor. Data for Pakistan was used to represent consumers and rural FATA for producers.

G. Results

1. Economic Surplus Analysis

22. The annual gain in economic surplus due to the project from the three representative commodities (wheat, maize, and vegetables) is PRs654 million. This is disaggregated as follows: (i) gain to producers in FATA $626 million, (ii) gain to consumers in FATA $25 million, (iii) loss to producers in rest of Pakistan PRs2,799, and (iv) gain to consumers in the rest of Pakistan PRs2,802. This annual gain in economic surplus was included as the agriculture benefit within the benefit–cost analysis.

2. Benefit–Cost Analysis

23. The estimated EIRR and ENPV from the benefit–cost analysis are in Table 2. The results indicate that the project is marginally economically justifiable with a mean EIRR of 12.4% and an ENPV of PRs133 million. The EIRR ranged from a minimum of 8.1% to a maximum of 17.2% (median 12.4%), and the ENPV ranged from a minimum of –PRs1,069 million to a maximum of PRs1,593 million (median PRs123 million). There is a 35% probability that the project would yield an EIRR less than the 12% threshold. Sensitivity analysis is not applied as the main parameters affecting project benefits and costs are treated as random variables and consequently the variability is captured within the risk analysis. All downside risks identified have been included and quantified in the analysis.

Table 2: Results of Economic Risk Analysis

Risk	**EIRR** (%)	**ENPV** (PRs million)
Minimum	8.1	(1,069)
Mean	12.4	133
Maximum	17.2	1,593

( ) = negative, EIRR = economic internal rate of return, ENPV = economic net present value.
Source: Asian Development Bank estimates.

3. Distribution and Poverty Impacts

24. The distribution of the project benefits across poor and nonpoor producers and consumers was estimated. The ENPV of PRs133 was derived from the present value of the benefits (PRs3,282 million) less the present value of the costs (PRs3,149 million). The results of the distribution and poverty analysis are in Table 3.

25. Government costs include the capital costs of the investment in dams and weirs. The distribution of impact on producers and consumers is based on the discounted economic surplus analysis and sharing of flood protection and watershed benefits between these two

groups. Consumers are a substantial beneficiary of the project, followed by producers in FATA. Producers in the rest of Pakistan experience a loss in welfare because of the (slightly) lower commodity prices associated with the shift in supply due to the project.

26. The primary beneficiaries of the project are the poor (PRs1,749 million) and extremely poor (PRs653 million). Of the total project benefit of PRs3,281, 73% goes to the poor. Therefore, it is concluded that the project will have a positive impact on improving the welfare of poor people in Pakistan.

Table 3: Project Benefit Distribution and Poverty Impact
(PRs million)

Item	Consumers	Producers (FATA)	Producers (RoP)	Government	Total
Government				(3,149)	**(3,149)**
Nonpoor	1,343	312	(776)		**879**
Poor	4,746	2,019	(5,016)		**1,749**
Extremely poor	1,780	759	(1,886)		**653**
Total	**7,868**	**3,091**	**(7,678)**	**(3,149)**	**133**

( ) = negative, FATA = Federally Administered Tribal Areas, RoP = rest of Pakistan.
Source: Asian Development Bank estimates.